ENGINEERING

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The assembly and erection of a gear train on an engine. (*Nurnberg photograph for* ENGINEERING)

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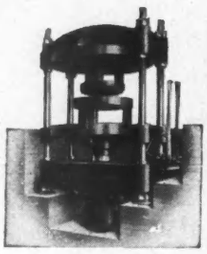

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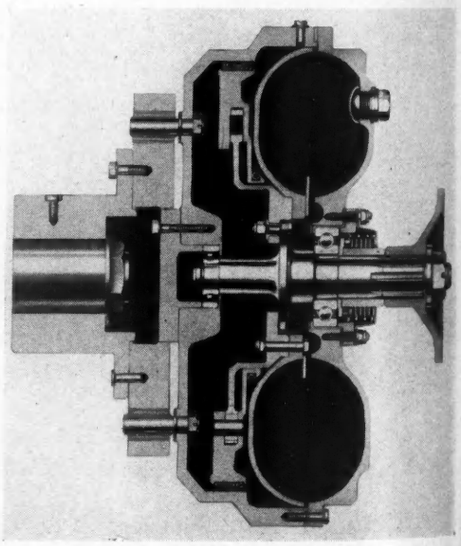

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ENGINEERING Impact

of a Status Symbol's Difficult Life

THE threatening shadow thrown over the future of the Rolls-Royce limousine by the £2,000 limit on capital allowance against company cars proposed in the Budget may now be seen to have been a potential part of the economic weather for a very long time.

Salaries measured in tens of thousands, wall to wall carpets in the office, a company Rolls (or the same manufacturer's Bentley) and a great syphoning off into surtax—this has been the top executive picture for a decade.

When the surtax lobby won through in the last Budget to a degree which means the surtax spectre retreats for the executive with a family all the way up to above £5,000 a year, it was inevitable that some other parts of the picture would come in for a little retouching to maintain the balance.

The £2,000 limit may for some people provide an inspiring picture of a cautious Government seeing to it that at least some of what it gives with one hand is recovered with the other.

But if the effect is so to limit the Rolls-Royce home market that the cost of production rises high enough to price the world famous car out of the export market, then serious damage will have been done in a more widespread field than the balance sheet of a single concern.

In the United States, in Europe and in other important parts of the world the Rolls-Royce car is a symbol of having arrived—and the approval of the most successful people is, like it or not, splendidly convincing to a host of others whose success is a matter of hope.

There is a place in the world for the World's Most Expensive Car and if one maker does not occupy the pedestal another one will. The indirect benefit to Britain of Rolls-Royce being the honourable holder of the title is not measurable but it is nonetheless certain.

Between now and the final passing of the Finance Bill it would be valuable improvement for Mr. Selwyn Lloyd, the Chancellor of the Exchequer, to look around the world and then find a way of leaving the top car in the top place.

High Speed Railway Building in Japan

IF DR. BEECHING is watching the development of overseas railways for ideas before he takes up his chairmanship of British Railways next month he might do worse than consider the Japanese.

The World Bank has just decided to lend the equivalent of £28·6 million to the Japanese National Railways for the establishment of what will be the fastest railway in the world, running through the heavily industrialized Tokaido area.

Consisting of only 16 per cent of Japan's land area, the Tokaido region contains 40 per cent of the population, more than 70 per cent of the national industrial product and 25 per cent of the agricultural output. Asaka, Yokohama, Nagoya, Kyoto and Tokyo will all be linked by the new high speed lines.

Lack of adequate transport facilities is holding back the Japanese from an even swifter development of the heavy industry, shipbuilding, electrical engineering, chemicals and textiles of the Tokaido district. Almost continuous congestion on the British pattern along the highway through the area is matched by the full-to-capacity working of the existing Tokaido narrow gauge railway.

The new Tokaido line, running parallel to the present line will carry only express passenger or express freight trains. Maximum speed for the passenger trains will be 125 miles an hour and of the goods expresses 94 miles an hour. A 20 per cent increase in efficiency on the narrow gauge line is expected from its freedom to concentrate on traffic suited to its facilities.

Total cost of the new railway will be equal to £193·3 million the World Bank loan covering only one-seventh of the cost and the rest being raised by borrowing in Japan. Construction work and the supply of rolling stock have been put out to world wide tender and the first 22 miles of the 311 mile system are due to be completed in April of next year. Service over the entire line is expected to start by the spring of 1964.

Self-propelled railcar sets will be used for passenger and freight services instead of locomotive hauled trains.

One Week On and One Week Off

ALTERNATE weeks of work and of holiday, or even a whole month of work followed by a month's holiday on full pay, these ideas were turned over in Ontario, Canada, earlier this week by Mr. Walter Woodford, secretary of the Institution of Production Engineers, who is visiting the United States and Canada.

Mr. Woodford was making the very reasonable point that while a man is tied to travelling to work five or six days a week, reductions in the length of the working week do not give him very much real benefit. Instead, then, of a 30 hour week, why not, asks Mr. Woodford, change the unit and have a 60 hour week followed by a week's holiday? At first sight this could be a working arrangement that would drive the production engineers to an early grave, but it could be that the morale boosting effect of regular weeks of paid leisure would cancel out the risk of declining standards during the long watches of the 60 hour week.

The Production Engineer's secretary goes on to pose the point that it might be worthwhile to work for a whole year in order to take a year's paid holiday, making the trip to Australia or Africa really worthwhile.

But is this the time for the productive part of the world to relax?

The basic contradiction in all this is that of the 2,000 million and more people on the globe now (and in 40 years' time the figure may be 5,000 million) at least half are undernourished, underemployed and in every way ill provided for. One of the major races between East and West, as Mr. Woodford acknowledged, is to try and be first in bringing the effects of manufacturing civilization to these peoples.

If the total production resources of the world are working in reality for little more than 1,000 million people at the moment, then when development of the late starting nations in Africa, Asia and Latin America has gone far enough, manufacturing effort will be wanted for all those future 5,000 millions—a prospect that must both awe and delight the production engineer. How this can be squared with half a year's work any time between now and some indefinite millenium is something of a mystery.

of Joining the Winning Team

THE 170 million people of the European Common Market countries make up not only the fastest growing market in the world, as is reasonably widely known, they are already by far the largest market for the importation of manufactured goods.

Between January and September of last year the manufactured imports of the six EEC countries were running at the rate of almost £400 million a month, or double the pace of the United States imports of manufactured goods.

About half of the EEC's imports were from one of the six countries to another, but the remaining half is still a great market, a market on the United Kingdom's doorstep and one in which our share is not what it should be.

A tenth of all EEC imports are provided by Britain, rather more than a tenth from the United States whose transport costs are, of course, much heavier than those from the United Kingdom, but whose coal, to take one example, is cheaper than the local product in certain important grades even when it arrives on this side of the Atlantic.

The rapid growth rate of the EEC members—West Germany, France, Italy, Belgium, Luxembourg and Holland—is shown by the latest issue of the Treasury's *Bulletin for Industry*, which gives the expansion in EEC imports from 1953 to 1959 as 77 per cent. Calculating in current prices, West German imports of manufactured goods in the same years rose by 283 per cent, for the Netherlands the rise was 91 per cent, for France 78 per cent, and Italy 55 per cent. Last year the speed of expansion was increasing.

The importance of these movements to British industry is twofold. As an export market it offers the opportunity to expand production and increase turnover on a scale, if the chances are successfully taken, to meet the ever growing costs of keeping up to date in new plant and in research and development. But the extent of the swiftly growing consumer demand is such that long production runs, giving otherwise unattainable economy in unit costs, are certain to be within the reach of West German and other manufacturers.

The advantage that this must confer in reducing prices competitively in home markets and in exports will be a major factor in future economic growth.

There cannot be much hope that from outside the European Common Market even the most efficient of British firms could compete under anything but serious handicaps against manufacturers exporting from the basis of so large a home market.

Against Britain's joining the EEC the arguments have so far substantially leant on the need to consider the Commonwealth countries and particularly their agricultural products. Whether these arguments are sound needs some examination.

Mr. R. A. Butler, the Home Secretary, has acknowledged the signs that the signatories of the Rome Treaty are prepared to make concessions in this field. From within the Common Market, with a share in a home market of 360 million people, Britain should do much better in export business—perhaps to the point of earning a trading surplus, the first requisite of a full scale programme of participating in the development of the least advanced members of the Commonwealth. Outside the Common Market the danger exists of the unsatisfactory trading position dragging on unresolved while the investment seeking Commonwealth nations turn more and more to West Germany, France and Italy for the credit, and the capital equipment, on which to build their industrial economies.

For her own good and for that of all the former dependencies who should still be able to look to London for help, the advantages to industry of Common Market membership appear too great for prolonged delay in opening full negotiations to be good sense.

UK Capital Equipment for Egyptian Industry

PROVISION of credit from private resources in London for purchases by the United Arab Republic of capital goods manufactured in the United Kingdom is a big step forward in the contribution of British industry to economic advance in the Middle East.

The £20 million credit, to be repaid over 5 years at 5 per cent, has been agreed between the Egyptian authorities and C. Tennant, Sons and Company, of London. Tennant are sure that when this money has been put to work there will be more credits.

Some investment will be in replacements in existing industrial installations, the rest in new equipment for expansion and new departures. British industries with whom contracts are expected to follow the credit line are those producing:—

Rolling mills
Chemical Plant
Mineral Extraction Equipment
Oil Extraction Plant
Textile Machinery
Power Installations

Without the rich oil incomes of other Middle Eastern states, Egypt has, more than most, the pressing need to build up her position as an importing-exporting manufacturing state. The United Arab Republic has a substantial Five Year Plan and the prosecution of its schemes has been by no means standing still. Although contracts placed with United Kingdom firms under the Plan are so far worth no more than about £E5·6 million, contracts up to £E53·8 million have gone to West German firms and up to £E46·9 with Soviet organizations.

The credit arranged by Tennant and the probable subsequent developments should go a long way to swinging the balance back towards the British manufacturer, and if a sound reputation for service and delivery is consolidated there are other Middle Eastern states, and other fields of manufacture in which cooperation may usefully be furthered.

Closed-Circuit TV Grows with its Uses

The increasing range of closed-circuit television equipment now available seems to grow in proportion to the applications to which it can be put.

For Restricted and Arduous Conditions

MEASURING only 9 in from lens mount to backplate and 3 in in diameter, the EMI mini-camera (Fig. 1) is suitable for use wherever space is restricted. The manufacturers claim it to be one of the smallest TV cameras in the world and this is borne out by the fact that it can view the interior of a 3 in dia pipe. It uses a 1 in Vidicon tube. It can also be placed inside an operating theatre lamp to bring an unobstructed view of a surgical operation to a large audience of medical students.

Fig 1 Using a 1 in Vidicon tube, this EMI camera is suitable for use in very confined spaces under arduous conditions.

The camera will operate without screening in environments where there is considerable noise or vibration such as in wind tunnels or near testing beds for rocket motors. Known as the Mini-camera type BC601, it is designed with its associated pre-amplifier for use with the standard Mk VI camera control unit.

To ensure minimum size and maximum reliability, as few components as possible have been placed in the camera itself. No ventilation holes are required so dust and swarf cannot penetrate the camera. Remote control facilities for zoom, focus, iris, pan and tilt, and a full range of accessories will be available. C mount, Vidiac and Viditel lenses can be used. The camera weights 6 lb and its pre-amplifier 5 lb.

EMI Electronics Limited, Instrument Division, Hayes, Middx.

Camera Operates with Standard Receiver

Designed for mass production, the "Nev Eye" closed circuit TV camera (Fig. 2) operates from ordinary mains supply to any standard receiver. The makers claim that it is the lowest priced TV camera in the world. This is achieved by the circuitry which allows the material cost to be kept to a minimum.

Output from the camera is a composite modulated frequency signal, and is tunable to any channel in Band 1. Synchronising impulses and blanking impulses are derived within the camera and are mixed with the vision signal to form a composite wave form which will lock any standard receiver working on the British 405 line system, or on the Continental 625 system. The radio frequency output is approximately 10,000 μV into 75 ohms for peak white modulation.

The camera tube is of the photo-conductive type and can be supplied with infra red or ultra violet sensitive targets at extra cost. Circuit features of interest are the vertical and horizontal generators, the vertical one being the driven type. The horizontal generator is designed to be "phase unstable," resulting in the line synchronization pulses having a run through characteristic relative to the frame which gives results approximating to a fully interlaced picture. The camera weighs 12 lb and its case measures 11½ by 5½ by 6¼ in.

Nottingham Electronic Valve Company Limited, East Bridgford, Notts.

APPLICATION	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Airports	■		■	■	■			■		■	■		■	■	
Bridges				■	■			■		■	■				■
Centrifugal Machinery		■			■	■			■	■					
Chemical Plant		■		■	■	■			■	■	■	■			■
Distilleries				■					■	■					■
Docks								■							■
Foundries		■		■	■	■				■					
Gas Plant				■		■	■			■	■				
Glass Plant		■		■		■			■						
Hydroelectric Plant				■		■									
Laboratories	■					■			■	■	■				
Machine Shops		■			■				■						
Mining				■	■	■									
Power Plant				■		■	■	■				■			
Railways						■	■	■					■		■
Shipyards					■										■
Water Plant				■		■	■	■	■						
Wind Tunnels						■	■	■							

APPLICATION CODE

A Training
B Production Control
C Surveillance
D Property Protection
E Material Handling
F Dangerous Viewing
G Remote Observation
H Traffic Control
I Process Control
J Work Co-ordination
K Centralised Record Viewing
L Display
M Silent Paging
N Information
O General Action Monitoring

Closed-circuit television applications in the engineering field, taken from data supplied by the makers of the "Nev Eye" who carried out a pilot survey for their own camera.

Mobile Unit for Hire Work

Ranks recently demonstrated their mobile closed-circuit television service for industry and education. It takes the form of a Duple-bodied Bedford coach provided with every facilitity for closed-circuit television programme presentation.

Although the mobile unit will largely be engaged on hire work in the industrial field, it will also act as a mobile demonstration studio for Dage television systems. On the spot demonstrations of closed circuit television can be given. Fig. 3 shows part of the interior of the unit.

The main items installed in the coach are as follows: A Dage ETS1 television control console with monitor screens and remote camera control facilities; sound control console with tape, disc and microphone sources; Bell and Howell model 631 16 mm sound projector modified for telecine work and a TV Selectroslide model 322 slide projector with remote control.

Equipment carried on the coach for use "on location" includes a range of Dage television cameras, video amplifiers, tripods and remote control pan and tilt heads.

Rank's television consultancy service has been expanded to meet the growing demands of industry, education and medicine.

Rank Precision Industries Limited, 37-41 Mortimer Street, London W1.

Closed Circuits at School

A company within the Pye group cooperated with the Middlesex Education authorities in experimenting with closed circuit television as an aid to teaching in schools.

Linked by microwave equipment, two schools two miles apart relayed a science lesson from one to the other. The master giving the lesson teaches his own class and at the same time faces two small Pye industrial television cameras. The second camera is used for enlarging small objects and for close-up work. A third is built into the console with a 16 mm film projector in order to provide telecine facilities.

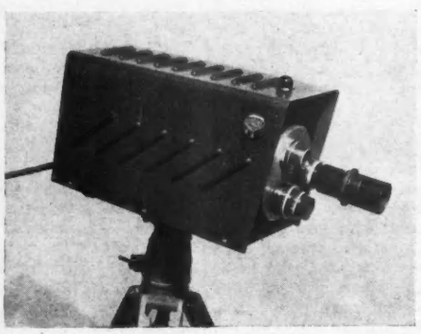


Fig. 2 The "Nev Eye" closed-circuit camera has been designed to work into domestic receivers.

The teacher wears a neck microphone and is able to select cameras and sound circuits by a switcher unit placed on his desk. He can see the picture being transmitted to the other school by a monitor screen.

Fig. 3 Interior of Rank's mobile unit which forms a closed circuit television service for industry.

The school receiving the lesson has a 27 in receiver. Sound arrangements between the schools allow the masters to hear talk back and monitor what is being said. This is done by wearing hearing-aid type earpieces, and a laboratory technician who also wears one operates the central control equipment. The whole system is designed to be self operated by the existing school staff.

Microphones allow the students to comment. They are fitted with a 2 ft parabolic dish which can be aimed at individuals and will pick up their remarks without them moving from their seats.

High Definition Television Limited, Cambridge.

Non-broadcast TV Tape Recorder

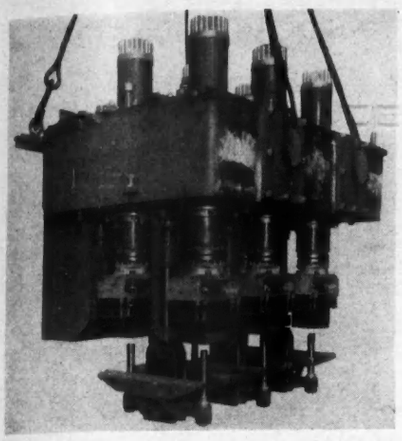
A television tape recorder designed exclusively for non-broadcast closed-circuit applications will soon be available from Ampex.

The recorder employs a single video record/reproduce helical-scan head in contrast to the Ampex broadcast television recorder. It operates at a slower tape speed and occupies less floor space. Known as the VR-8000, the recorder is designed for operation by personnel with the minimum of technical training.

Ampex Great Britain Limited, Arkwright Road, Reading, Berks.

Heavy Current Switchgear for Pumped-Storage Scheme

Wide use is made of non-magnetic steel and alloys in this heavy-current switchgear for the Ffestiniog pumped-storage scheme.



In the Ffestiniog pumped-storage scheme in North Wales the power plant comprises four 78·9 MVA generator/motor sets, each circuit being controlled by a 3,000 A oil circuit-breaker. In normal power generation schemes the alternator is connected direct to the step-up generator transformer, switching being carried out on the high-voltage side of the transformer. With a pumped-storage scheme, power can flow in either direction. Thus there is a need for switchgear between the power plant and the generator-transformer.

The comparatively low voltage involved and the proximity of the switchgear to a large power source means that a non-standard, heavy-current, high-breaking capacity unit has to be employed. Two such units are being supplied by GEC and they control the circuits of the generator/motors. Each switchboard is rated at 16 kV, 1,500 MVA and consists of three panels, the two end units containing 3,000 A oil-circuit breakers and the central section the heavy current connections between the 6,000 and 3,000 A bus-bars. One of the panels removed from its tank is illustrated. They measure 23 ft long by 12 ft deep and high.

A feature of the design is the wide use of non-magnetic steel for the bus-bar chambers and of non-magnetic alloy for the framework and panels. This is a necessary adjunct of such heavy-current gear to keep the eddy-current loses, and consequently heating, to a minimum.

Condenser-type tubular bus-bars are used inside the building to link each generator-transformer with its 3-panel switchboard. Connections between the 6,000 and 3,000 A bus-bars are made inside an oil-filled chamber contained in the centre panel.

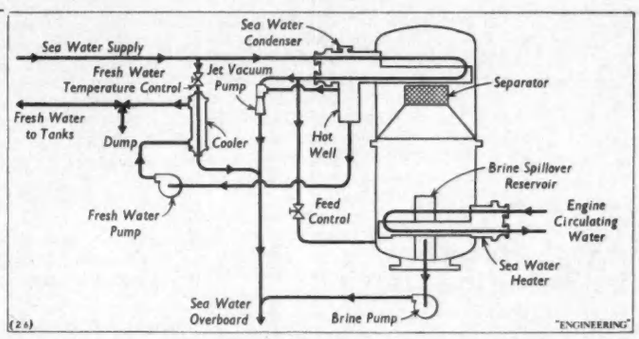
Protective measures fitted to the generator/motors are of the conventional circulating current system in which the currents entering and leaving the protected zone are compared, any difference indicating a fault. This requires two sets of three current transformers for each generator/motor. One of these sets is located inside the GEC switchgear on the bus-bar side of the 3,000 A circuit-breaker.

Any fault arising on the 16 kV bus-bar system immediately causes the tripping of both 3,000 A circuit-breakers and also of the 275 kV switchgear at the switching station. Duo-bias protection is fitted to both generator/transformers.

The General Electric Company Ltd, Erith, Kent.

Economical Evaporators

Engine cooling water or any hot water system can provide the heat source for the range of "Aquavap" evaporators. They can, depending on capacity, produce from 2 to 45 tons of fresh water per day, and are sold as packaged units.



The Maxim "Aquavap" range of evaporators are designed to distill fresh water from salt or brackish water where a larger unit would be uneconomic or impracticable.

They are of the heat recovery type and utilise the waste heat from the cooling water of an engine or water heated from any heat source having a temperature of 150° F or more. Only a small amount of electrical power is required for the pumps and salinity panel, but this is normally not enough to necessitate any increase in generator capacity.

Operating costs are low and because the sea water is boiled under vacuum at very low temperature (approximately 125° F), there is little scale formation.

The operation of the Aquavap is as follows: The hot water is pumped through the lower heat exchanger (raw water heater) and is returned to the circulating system. Raw water is pumped through the distiller condenser and discharged. Air and non-condensible gases are removed by a motor-driven vacuum pump, or a jet vacuum pump is fitted on the smaller capacity models.

Feed water supply flows from the distiller condenser outlet through a flow indicator and feed control valve into the evaporator shell. The excess feed (waste water) is drawn off from the shell by the waste raw water pump and discharged.

The raw water boils in the lower section of the evaporator shell and the vapour produced passes through a specially designed separator. This gives an acceptable purity. The purified vapour then passes to the distiller condenser tubes where it is condensed and the resulting fresh water collects in the hot well below the condenser. From there it is pumped to the storage tank.

The Aquavap units are produced as packaged plants and are available in an ouput capacity range of 2 to 45 tons per day.

AMF Limited, Maxim Division, 4-6 Saville Row, London, W1.

Trailer with Protected Wheels for Shot-Blast Work

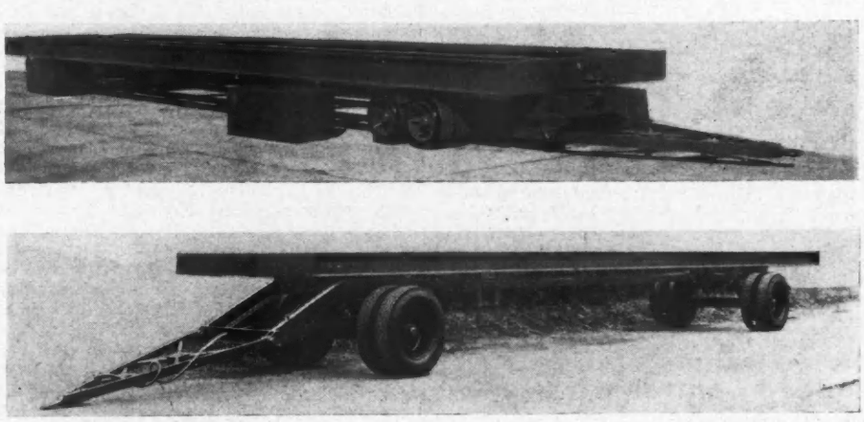
Two types of trailer by Taskers have been supplied to the ACD Bridge Company for use in the construction of the new Forth Road Bridge.

Four of the type shown in the top picture have been supplied to the Metallisation plant at Drem. These trailers which are 40 ft long by 8 ft wide are designed to carry large sections of the bridge past a shot-blast plant preparatory to zinc spraying. Some of these sections are 60 ft long and weigh as much as 35 tons. To save the 16 solid-tyred wheels from becoming impregnated with shot they are covered by wheel spats, one of which is shown removed.

The low height drawbar can be easily detached and the turntables—there is one at each end—can be locked in a straight ahead position.

The lower picture shows one of the four wheeled trailers of 15 tons capacity. Two of them have been supplied to the same dimensions as the type mentioned above. They are used for hauling structural steelwork around the Drem stacking yard.

The forecarriage is set down to provide low towing by an industrial tractor. A turntable is fitted at one end only. Air operated brakes are fitted to the rear wheels which are also controlled by a hand brake.



Taskers of Andover (1932) Limited, Andover, Hants.

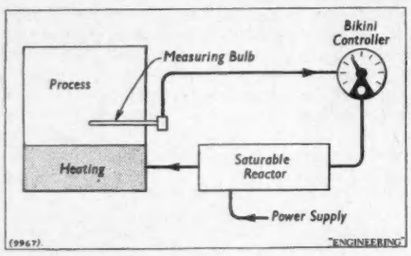
The trailer shown above has protected wheels because it transports large steel sections past a shot-blast plant. One spat is shown removed. The lower trailer carries steelwork around Drem.

Controlling 10 kW of Heat without Contacts

No moving parts are used in a temperature control system employing the " Bikini " temperature controller and a saturable core reactor.

The degree of reliability which the makers claim for this controller is coupled to that of saturable core reactors to give temperature control of circuits of up to at least 10 kW with no maintenance and according to the makers an almost indefinite life.

Both the controller and the saturable core reactor operate from a ¼ in dia measuring bulb



The controller can be up to 300 ft away from the point of measurement.

of stainless steel construction. Two types are available, one for use at temperatures up to 500° C and the other up to 850° C. Controllers covering 73 temperature ranges with spans as short as 50° C and as wide as 600° C are available.

Control differential is only 0·5° C and, if required, the controller can be located as much as 300 ft away from the point of measurement.

Fielden Electronics Limited, Wythenshawe, Manchester 22.

Cargo Handling by Swinging Derrick

Deck cranes have become more and more popular in new ships but they have certain limitations, including lifting capacity, length of jib, space needed for mounting, weight and initial cost.

The Hallen derrick which is simple in design combines the advantages of the deck crane with those of the conventional derrick. Put simply, the new device makes use of the twin topping lift principle which allows for easy control of a single derrick. Up to 100 tons can be handled.

The entire gear can be operated by one man using the specially designed Siemens Schuckert control gear. There are two levers, one to control all the movements of the derrick, the lever, being moved in the direction which the derrick is required to travel, and the other to use for hoisting or lowering.

Fitted to the mast is a fixed outrigger which keeps the topping lifts at a suitable angle to each other so that the derrick will hang steady even if swung out to about 90° over the ship's side. In addition, the outrigger keeps the derrick steady in the event of the ship having a heavy list.

The derrick is supported by two topping lifts attached to the outer ends of the crosstree, each topping lift consisting of a single wire to which tackle is attached. Three Siemens Schuckert/Donkin ac winches operate the derrick two of which are used for the topping lifts and the third for cargo operation.

MacGregor and Company (Cargo Handling) Limited, 5 Camomile Street, London EC3.

Wide Range Speed Control

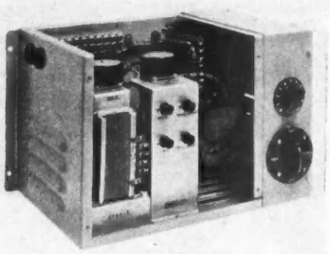
A wide range of speed control using a moderately priced unit that yet gives good accuracy, are claims put forward for a new range of electronic motor controllers.

Motor speed can be held to within ± 1·5 per cent of full speed over the complete range from full load to no-load; with feedback, this figure can be improved to 0·25 per cent. Variations resulting from fluctuation of mains voltage and frequency are kept to 1 per cent in the first case and to 0·5 per cent in the second (the latter figure including long term drift) for voltage changes of −10 to +5 per cent and for frequencies from 47 to 65 cycles.

A simple patented circuit is used embodying thyratron rectifiers with a feedback loop that compares the voltage across the armature of the motor to a reference voltage. The latter can be varied by a potentiometer which therefore becomes the speed control setting for the unit. The controller will also operate from a tacho-generator in place of the armature voltage signal which will give rather better long term stability and closer control.

Control can in fact be obtained by monitoring any direct or indirect function that the motor performs using the signal to actuate the controller and thus correcting the motor speed. The setting range can be varied over a ratio of more than 100 to 1 with stepless adjustment.

The range of standard units at present available covers motor sizes from fractional to 15 hp. Standard models will operate in ambient temperatures from −20° C to +35° C (−40° F to +95° F) and in conditions of humidity up to the worst encountered in industrial situations. In addition, models suitable for use in the tropics are made. All are suitable for use in mobile equipment, and are arranged for wall mounting.



Controller will accurately maintain preset motor speeds over a range of 100 to 1.

Henry A. Cole and Company Limited, 287/289 Old Street, London EC1.

Forces Applied by the Foot

For assessing the resistance of flooring materials to wear by foot traffic, general purpose machines measuring abrasion resistance have not proved suitable. Apparently this is due to the complexity of the interaction between foot and floor during walking and to the existence of a number of mechanisms of wear dependent on the materials involved.

A paper published for DSIR by HM Stationery Office entitled " The Forces Applied to the Floor by the Foot in Walking " describes the design of a testing machine that simulated the abrasive interaction as closely as possible. With the machine, measurements were made of the forces applied to the floor surface by the foot both in straight walking and in turning on level ground.

The forces of walking were determined by means of a " force plate " using resistance strain gauges. These forces were related to measurements of the area of contact between the foot and the floor (recorded cinephotographically), values of changing pressure thus being obtained.

The unit consists basically of a steel plate ¾ in thick, supported on four hollow columns of aluminium alloy (carrying the strain gauges) which are fixed to a lower ¾ in thick steel plate. A footstep on the upper plate compresses and bends the columns but it also induces vibrations, and this makes for difficulty in recording the rapidly changing strains produced by the foot. The system was therefore provided with a damping mechanism. Horizontal vibrations are damped by shearing a thin film (0·02 in) of viscous fluid held between vanes connected to the top and bottom plates. The paper resistance strain gauges were stuck to the columns by an elaborate procedure to ensure firm adhesion.

The paper describes the techniques of measurement used, summarises the results and formulates the design criteria for an abrasion testing machine.

Roof-top Boilers for Process Steam

Oil-fired packaged boilers are to be fitted on the roof of a bottling factory to provide all the process steam needed. Among the reasons given by the makers for siting them there are: (*a*) Ground floor and basement space are released for production, and (*b*) steam supplies are piped overhead thus keeping the floor area clear and giving a saving in the length of piping.

The three Stone-Vapor type OK4625 boilers have a combined output of 9,000 lb per hour.

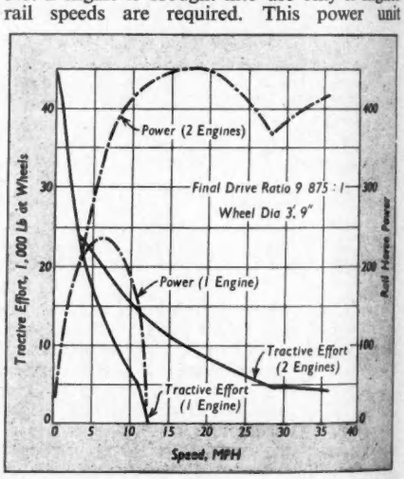
Stone-Platt Industries Limited, Oceanic House, 1A Cockspur Street, London SW1.

Versatile Diesel-Hydraulic Locomotive

Of special interest to railways needing an economical unit for heavy shunting and transfer or trip working on main lines is the " Taurus " diesel-hydraulic locomotive.

Now undergoing trials with British Railways, this locomotive, powered by two Rolls-Royce C8SFL engines, each developing 311 hp, is the first to be fitted with the new Rolls-Royce type " S " hydraulic transmission arrangment.

Briefly, the principle used in the locomotive is that the two prime movers are installed in opposed positions on either side of the central cab and drive through torque converters into a differential gearbox. From this gearbox, which is mounted at the rear of No. 1 power unit, a cardan shaft drives to the final drive gearbox mounted on one of the intermediate axles. No. 2 engine is brought into use only if higher rail speeds are required. This power unit



Taurus locomotives can perform the heaviest shunting duties and haul 500 ton trains at 35 mph.

drives through a cardan shaft to the differential and when introduced will take its share of the load above speeds of about 3½ mph. With both engines in use, a good performance is available for line duty up to about 35 mph hauling trains of up to 500 tons.

Such performance means that the Taurus will be capable of filling the present gap between the purely shunting locomotive limited to about 400 bhp and the 800/1,000 bhp diesel-electric or diesel-hydraulic BoBo type.

Yorkshire Engine Company Limited, Meadow Hall Works, Sheffield 9.

Plain Words

By Capricorn

REPORTS should be written before, not after, a job has been completed. Why put it in writing when the work is finished, when nothing can be changed? I realise we can learn from our mistakes, but who is likely to do full justice to his follies in writing a report? Put it all in writing in advance, and mistakes may be avoided.

This is the conclusion that I drew from a conversation with two nuclear engineers the other day. They assured me that their company's success in keeping up to schedule arose from the detail in which they prepared their building programmes. Every operation was planned to the last shovel of cement.

Commissioning the finished nuclear power station was planned with equal thoroughness. They told me that a commissioning schedule might begin: "At 7.30 on the morning of 25 August, the chargehand enters the station and switches on the lights." I laughed. "Surely the chargehand has enough gumption to do that without having it in writing?"

"Perhaps," they replied, "but each operation has to fit in with other operations, and by setting it down, the whole process can be thought over, timed and revised without risk to the hardware. Don't forget, too, that a nuclear power station may cost £50 million and, amortised over 20 years, it works out at some £10,000 a day. Obviously we can't afford to waste a minute."

He convinced me. It may seem stupid to state the obvious, but the human mind is fallible and even the obvious can be overlooked—with fatal consequences. "Put it in writing" is a familiar precaution, designed to overcome the weaknesses of human memory and obligation; but it has now become indispensable to the complex operations of engineering manufacture. Everyone must know his part; everything must happen at the right moment, as in a military attack.

Writing is a way of thinking slowly in preparation for acting fast. It is the oldest method of programming—used long before the computer was even thought of.

Job manuals, written-down procedures, rules of practice are similar in function to the subconscious mind: relegate routine, like walking and breathing, to the subconscious and you can give more attention to the tricky and unexpected problems that arise. Military drill, likewise, is not designed to destroy initiative, but to make so many actions automatic that the soldier is free to exercise initiative when the occasion calls.

As engineering activity grows more complex and calls for clearer thinking, as the rate of working in "real time" becomes faster, as more and more specialists are involved in cooperative tasks, as engineering installations rise in cost, so it becomes more important to set it down in writing first; to use a written draft, not the plant itself, for experimental purposes.

Testing to destruction—accidentially—can be expensive. But paper is relatively cheap.

Letters to the Editor

National Use of Technical Information

SIR, After talking recently to Mr. A. I. Chërny of the All-Union Institute of Scientific and Technical Information of the USSR Academy of Sciences, I would like to ask whether we, in Britain, are doing nearly enough to make the most effective use of publishing technical information? I doubt whether we have an adequate array of abstract services, or whether we are yet alive to the proper use of Information Scientists.

Mr. Chërny informed me that the number of abstracts published by the sections of the Russian journal *Referativny Zhurnal*, which is published by his Institute, was in excess of 650,000 in 1960. This journal abstracts some 12,000 journals a year, and includes abstracts of selected patents of 24 countries. The *Referativny Zhurnal* is, of course, Government-sponsored and employs 2,000 staff with a further 15 to 20 thousand external abstractors. The number of abstracts of chemical and related subjects (for example biochemistry, and metallurgy) exceeded 170,000 in 1960.

At present, the *Referativny Zhurnal* is divided into 16 sections, but it is likely that the future will bring a division into as many as 100 sections. The main objection by users of this particular journal has been the complete absence of indexes, although Mr. Chërny informs me that these will soon be in production. The *Referativny Zhurnal* is available in London (Chemical and Biological Chemistry Sections) at the Patent Office Library.

It is interesting to know that the largest American abstracts journal, *Chemical Abstracts*, published by the American Chemical Society on a non-profit basis, produced some 125,000 abstracts in 1960. The time spent on indexing is estimated by *Chemical Abstracts* to be equal to the time spent in the actual production of the abstracts.

These specialist abstract journals, backed by similar freely-available journals such as *Chemisches Zentralblatt*, are used by too few information workers. The large abstracting services, although necessarily lagging behind the appearance of the original articles (with some obscure journals a period of up to two years delay is commonplace), offer an efficient and permanent store of information. The operating costs of an abstracts service are high and they must, therefore, serve large slices of the community, with a consequent loss in the service offered to the specialist consumer.

The necessity for current searches by information specialists (that is, by scientists with the requisite specialist training) was made the subject of a recommendation at the Rome meeting of Technical Information Officers (1956) which was engaged in considering improvements in European productivity. This recommendation stated that management should ensure that a qualified person would be appointed with the responsibility of looking for new technical ideas and the dissemination of technical information. Much of the writing on this subject has been "preaching to the converted," as many large industrial concerns employ information staff, or possibly compromise with special librarians. Librarians should not be asked to cope with translating, editing research reports, abstracting, advising on patent law, typographical layout, lecturing and arranging tours and visits. Some librarians are asked to fulfil such duties, but they can scarcely be asked to interpret research results in the light of other research.

For the smaller firms, with perhaps a limited budget, it is still possible, and even essential, for them to keep abreast of current research developments by using outside services, as in this way they will help to maintain and improve their general productivity level. The smaller firms that are unable to justify information departments of their own can still gain valuable knowledge of development and technique through the medium of the technical trade journals, particularly those that operate a readers' inquiry service to amplify the information given in abstracts. Similar in function is the service operated by the Department of Scientific and Industrial Research in their *DSIR Technical Digests*.

The specialist in information work has the necessary training to know where to locate these journals. Logically, he should have some linguistic ability and knowledge of the community he serves, so as to present the information in an easily assimilated form, preferably as an abstract. For those languages unfamiliar to him, he must know of reliable (and therefore specialist) translators able to help him. Some five years ago, concern was felt as to the inadequate number of scientists with a knowledge of Russian. Now, intensive courses have eased the situation, but already the future likely output of China is presenting yet another linguistic hurdle. The American machine translation projects *Rusdic* and *Chindic* may eventually assist, but these projects will be some years before coming to fruition.

The specialist staff who provide the information to the user, or to give them their correct name, the Information Scientists, should have the confidence of management in order that they may be entrusted with the knowledge of future developments, thus enabling them to provide only essential information. The time of scientist and industrialist can be far better spent by leaving the dissemination of information—collection, distribution, storage and retrieval—to the people trained for the job.

What manner of man makes an Information Scientist? Of scientific training, preferably with research experience, he must have the unwavering curiosity of the scientist *par excellence*. Of the linguistic ability we have spoken, and, together with the necessary training, he must have a tactful approach so that the answer is not only digestible but is also acceptable. The training is partially by experience and partially by a course of instruction, such as that sponsored by the professional body maintaining standards and issuing qualifications—the Institute of Information Scientists. Our university students rarely know of the workings behind the library counter. Yet Mr. Chërny informs me that, in the USSR, all undergraduates participate in a course of study designed to initiate them into methods of documentation.

The provision of an information department as an adjunct to research and development is recognized by many industrial firms. The results of such departments are not capable of representation on a company account sheet. The department should be located so that there is rapid communication to the site of productivity and should not only have a direct line of communication with senior management for the provision of information concerning improved principles, but also should be in close contact with that middle stratum of management which deals with the finer details of production. The difficulty which faces the Information Scientist is that of obtaining "the full story." All too often time has to be spent in eliciting the true inquiry and expanding the question actually asked—the inquirers tell the Information Scientist what they think he should know.

"Follow-up" is all too often neglected. On the Continent and in the United States, after providing the answer to an inquiry, there is frequently a further check to ensure that the specific problem is solved. In this country, we often operate on the principle "If we hear no more, they must be satisfied."

If it is necessary for patents to be covered, some knowledge of the special procedure and law is required. It is interesting to note that the Prior Art (that is, previously invented or known subject matter) Information Centre in Germany estimates that some 65 per cent of inventive talent is abortive because unknowingly the item was independently discovered beforehand. Co-operation between industries that are nominally competitors is not necessarily detrimental. The

German electrical engineering firm Allgemeine Elektrizitäts Gesellschaft publishes *Magazine Review* and provides a practical example of cooperation for the benefit of the industry as a whole. Similar dissemination is achieved by research organizations and trade associations who may levy a subscription on their members.

The Government has approved the establishment by the Department of Scientific and Industrial Research of a National Lending Library of Science and Technology, which is at the moment being set up at Thorpe Arch, near Boston Spa in Yorkshire. A National Reference Library, of Science and Invention, will be set up in association with the British Museum Library. In the United States during the past decade, the cooperation of a large number of universities under the Farmington Plan has ensured that at least one copy of important foreign books is readily available somewhere in that country.

Sources of information relevant to the particular industry are generally available through a trade association, or perhaps at a more local level, through a Chamber of Commerce. Inquiries by firms without information departments and not members of such associations, might be directed through the DSIR or through ASLIB, the latter body among other functions serving to provide a network of national and international contacts between information officers and librarians.

The appearance of the Information Scientist attached to firms in post-war Britain, as opposed to his pre-war counterpart the consultant, is evidence of the growing realization that active measures are essential in order to present ideas rapidly and accurately to industry so as to ensure improving levels of productivity.

Yours faithfully,

B. T. STERN,
Information Officer.

The Chloride Electrical Storage Company Limited,
Research and Development Laboratories,
Manchester.
5 May, 1961.

Damping a Rotating Shaft

SIR, In an article which you kindly published entitled "Unbalanced and Initially Bent Shafts" (ENGNG., 25 Nov., '60, p, 735), I dealt with certain aspects of the whirling of shafts. The article provoked adverse comment from Mr. Joseph Morris in what seemed to be rather muddled terms (23 Dec. '60, p. 848). I therefore sorted his criticisms out mathematically (3 Mar. '61, p. 312), separating what was valid, but unlikely and irrelevant, from what was simply wrong. In a second letter (5 May '61, p. 621) Mr. Morris returns to the attack without any effort at detailed justification, just his own personal opinions.

This correspondence (which I am afraid must seem tedious to many of your readers) has been joined by Mr. Morris's former protégé, Dr. E. Downham (28 April '61, p. 588). May I, please, deal with Dr. Downham's assertions, surprising though they are? At least his difficulties are readily identifiable and easily resolved.

If the spindle marked "shaft axis" in his Fig. 1 is to be taken as the sole location of elastic restoring forces, then shaft (*a*) is bent and shaft (*b*) is unbalanced. If the discs are supposed to be the elastic members, then the double lines marked "shaft axis" are irrelevant and both shafts are bent. In the latter event, a glance at the very first sentence of Jeffcott's original paper will reveal that the problem is not that of the unbalanced shaft, nor is it that to which Jeffcott addressed himself.

Dr. Downham here (and elsewhere) attaches literal significance to the idea of a disc—or, as he prefers to call it, a "rotor"—yet Jeffcott made his adoption of it *as an illustration* abundantly clear. Jeffcott's analysis illustrates the motion of a simple thin rod without any disc perfectly well, and it was meant to.

Referring now to Fig. 2 of Dr. Downham's letter, we find a shaft which serves to confound its author utterly. If the density is uniform then the mass axis of the shaft coincides with the axis of centres of cross-sectional area. If Young's modulus is also uniform throughout, then the elastic axis also coincides with the axis of centres of cross-sectional area. Thus the elastic axis coincides with the mass axis so that the shaft is not unbalanced. But these two axes are not straight, so the shaft is bent.

There are two final questions. Dr. Downham asks "when is a shaft not a shaft, but a rotor?" This is a matter of English usage. I personally would say that a shaft is a "rotor" when its speed is well below its first critical. As to the second question—well, may I say, simply, that one has to draw the line somewhere?

Yours faithfully,

R. E. D. BISHOP.

Department of Mechanical Engineering,
University College London, WC1.
8 May, 1961.

Events in Advance

American Chemicals Display their Merits

NO FEWER than 475 American organisations of all sizes are reported to be already making arrangements for their displays at the 28th Exposition of Chemical Industries, which is scheduled to be held at the Coliseum, New York, from 27 November to 1 December, next.

These exhibits will provide a representative cross-section of the whole range of materials, equipment and services now being used by the chemical process industries in the United States. In addition to this optimistic outlook on the part of firms engaged in the American chemical process industry, the exhibition management record that there have been signs of increased interest in the exhibition by persons and firms overseas.

The organizers of the event are the International Exposition Company, 480 Lexington Avenue, New York 17, to whom all communications should be addressed.

Exhibitions and Conferences

Arranged in Chronological Order

Institution of Heating and Ventilating Engineers: Summer Meeting.—Wed., 7 June, to Fri., 9 June, at Torquay. A post-conference tour on Sat., 10 June, will be arranged if there is sufficient demand. Offices of the Institution: 49 Cadogan Square, London, SW1. Tel. SLOane 3158.

Suppliers for Furniture, Upholstery and the Wood Processing Industries, International Fair of (INTERZUM).—Thurs., 8 June, to Sun., 11 June, 1961, in Cologne. Inquiries in the United Kingdom should be sent to Mr. Neven du Mont, 123 Pall Mall, London, SW1. Tel. WHItehall 8211.

Chemical Engineering, European Congress, comprising the **1961 ACHEMA Congress; the 13th Exhibition and Congress of Chemical Engineering** organised by DECHEMA; special meeting of the **Gesellschaft Deutscher Chemiker**; annual meeting of the **DECHEMA Deutsche Gesellschaft für Chemisches Apparatewesen;** annual meeting of the **Isotopen, Studiengesellschaft;** and a symposium on "The Physical and Chemical Durability of Structural Materials in the Chemical Industry," being the **15th Meeting of the European Federation of Corrosion.**—Fri., 9 June, to Sat., 17 June, 1961, at Frankfurt on Main. Apply to DECHEMA, 25 Rheingau-Alee, Frankfurt on Main, Germany.

Poznan International Fair, 30th.—Sun., 11 June, to Sun., 25 June, 1961, in Poznan. Official forwarding agents: P.S.A. Transport Ltd., 70 Old Broad Street, London, EC4. Tel. AVEnue 2424.

Bordeaux International Trade Fair, 40th.—Sun., 11 June, to Mon., 26 June, 1961, in Bordeaux. Agents: Auger and Turner Group Ltd., Thorn House, Upper St. Martin's Lane, London, WC2. Tel. TEMple Bar 9081.

British Electrical Power Convention.—Mon., 12 June, to Thurs., 15 June, 1961, at Eastbourne. Offices of the convention: Winsley Street, London, W1. Tel. MUSeum 4040.

Technical Writers' Institute, Ninth Annual.—Mon., 12 June, to Fri., 16 June, 1961, at Rensselaer Polytechnic Institute, Troy, NY, USA. Theme: "The Technical Writer and His Relation to the Expanding Uses of Communications in Modern Industry and Government." Apply to Professor Jay R. Gould, Rensselaer Polytechnic Institute, Troy, NY, USA.

Electronic Engineering: Conference on Components and Materials Used in.—Mon., 12 June, to Sat., 17 June, 1961, at the Central Hall, London, SW1. Sponsored by the Electronics and Communications Section and the Measurement and Control Section of the Institution of Electrical Engineers. Apply to the secretary, Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. Tel. COVent Garden 1871.

Meetings and Papers

Faraday Society

OXFORD
"Chemical Kinetics of the Thermal Ionisation of Xenon", by Professor Harold S. Johnston (University of California). Physical Chemistry Laboratory, South Parks Road, Oxford. Mon., 15 May, 5 p.m.

EDINBURGH
"Large Degrees of Tunnelling and Chemical Reaction Rates," by Professor Harold S. Johnston. Chemistry Department, University of Edinburgh, West Mains Road, Edinburgh 9. Thurs., 18 May, 4.30 p.m. (Both meetings open to the public: no tickets required.)

Institution of Chemical Engineers

LONDON
"Biochemical Engineering": symposium. Papers include "Developments in Fermentation," by D. J. D. Hockenhull; "A Rate Equation for the Heat Sterilization of Air," by R. Elsworth, E. J. Morris and D. N. East; "Physical Rate Processes in Industrial Fermentation, Part III—Mass Transfer from Fluids to Solid Particles Suspended in Mixing Vessels," by P. H. Calderbank and S. J. R. Jones; "Aeration Processes for the Biological Oxidation of Liquid Wastes," by A. L. Downing and R. W. Bayley; "Equipment for Laboratory and Pilot-Plant Scale Fermentations," by A. Parker, E. F. McCann, D. Pickles and D. G. Wright; and "Aeration and Agitation in 5 Litre Fermenters," by N. Blakebrough and G. Hamer. Royal Commonwealth Society, Craven Street, WC2. Tues., 30 May, 2.30 p.m. to approximately 6.45 p.m. (Registration required: fees payable.)

Institution of Civil Engineers

LONDON
Annual General Meeting. Tues., 13 June, 5.30 p.m.*

Institution of Electrical Engineers

LONDON
"Electric Traction"; Annual Lecture, by J. A. Broughall. Utilization Section. Thurs., 25 May, 5.30 p.m.*

Institution of Electronics

LONDON
"Aerial Techniques," by C. F. Whitbread. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Fri., 19 May, 7 p.m.

Institution of Mining and Metallurgy

LONDON
"Reaction of Beryl with Sodium Fluorosilicate Used in Extracting Beryllium from the Mineral," by K. R. Hyde, Professor P. L. Robinson, M. J. Waterman and Dr. J. M. Waters; and "Dispersion of Tin in Soil over Mineralization at Sungei Lembing, Malaya," by Dr. J. S. Tooms and S. Kaewbaidhoon. Geological Society, Burlington House, Piccadilly, W1. Thurs., 25 May, 5 p.m.*

Institution of Plant Engineers

BIRMINGHAM
"Acoustics," by E. G. Ewing. Birmingham Branch. Imperial Hotel, Temple Street, Birmingham. Sat., 27 May, 7.30 p.m.

Institution of Public Health Engineers

LONDON
Annual General Meeting at 4.30 p.m. (Open to corporate members only.) "The Development of Bracknell New Town, with Particular Reference to Its Effect on Local Government Administration," by H. Charlesworth, at 6 p.m. Caxton Hall, off Victoria Street, SW1. Fri., 9 June.

Royal Society of Arts

LONDON
"Bauxite and Its Importance to the Commonwealth," by Wilfred Brining. Henry Morley Lecture. Thurs., 25 May, 5.15 p.m.*

Society of Instrument Technology

LONDON
Annual General Meeting, at 6 p.m. Presidential Address, at 7 p.m. Manson House, 26 Portland Place, W1. Tues., 23 May.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. An asterisk (*) is placed where it is understood that refreshments are available prior to the time stated.

Faraday Society, 6 Gray's Inn Square, London, WC1. (CHAncery 8101)
Institution of Chemical Engineers, 16 Belgrave Square, London, SW1. (BELgravia 3647)
Institution of Civil Engineers, Great George Street, London, SW1. (WHItehall 4577)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (COVent Garden 1871)
Institution of Electronics, 78 Shaw Road, Thornham, Rochdale, Lancs. (Oldham Main 6661)
Institution of Mining and Metallurgy, 44 Portland Place, London, W1. (LANgham 3802)
Institution of Plant Engineers, 2 Grosvenor Gardens, London, SW1. (SLOane 0469)
Institution of Public Health Engineers, 179-181 Vauxhall Bridge Road, London, SW1. (VICtoria 3017)
Royal Society of Arts, John Adam Street, Adelphi, London, WC2. (TRAfalgar 2366)
Society of Instrument Technology, 20 Queen Anne Street, London, W1. (LANgham 4251)

Dynamics of Halting a Line of Traffic

By applying the principles of dynamics and observing the movement of vehicles in the Mersey Tunnel, the author deduces that for safe spacing there is one speed which corresponds to maximum traffic flow.

By W. A. Woods

Mechanical Engineering Department, University of Liverpool

THE motion of an ideal line of traffic is analysed in this article using fundamental principles of dynamics. Figures given in the *Highway Code*[1] are correlated on the basis of a simple theory which is then extended to examine the rate of flow of traffic. Conditions for maximum rate of flow are derived and their implications discussed. Several vehicle spacings are examined and it is shown that these depend upon the type of signal to which the traffic must be capable of responding and the final vehicle spacing which is required.

It is shown that for a safe spacing there is one speed which corresponds to a maximum flow of traffic. This optimum speed is shown to be independent of the driver's reaction time and dependent upon the square root of the product of the vehicle length and coefficient of friction between the vehicle and the road.

The general results show that the vehicle flow rate increases as the vehicle length is decreased, as the coefficient of friction is increased and as the driver's thinking time is decreased. The results are discussed and shown to be consistent with the spacing required for traffic in the Mersey Tunnel. Finally, practical suggestions are made based upon the interpretation of the results derived from the theory.

SAFE SPACING

This study is the result of an academic interest n transient flow of gases in pipes and practical experience of unsteady vehicular motion in the Mersey Tunnel. As there is a lack of available empirical data for the Mersey Tunnel, the paper is purely theoretical. A simple theory of vehicular spacing is derived and the mathematical assumptions used are probably realistic for traffic flow in this tunnel during the peak period. The "safe spacing" discussed in the paper may well be larger than that which occurs in practice.

Although much work has been carried out in the United States of America and a certain amount in this country, mainly at the Road Research Laboratory, empirical data are still required and it is hoped that this article will stimulate some interest in this particular problem. (References to Lighthill's classical fluid flow analogy[2] and to other flow and traffic studies[3–18] are given at the end of the paper.)

When a continuous stream of traffic moves along a road it is necessary to separate each vehicle by a certain distance so that, in the event of one vehicle stopping suddenly, the vehicles behind will not collide. (This article deals with a relatively short line of one-lane traffic; a treatment of traffic flow on long crowded roads together with a survey of previous work has been prepared by Lighthill and Whitham.[2])

A steady stream of identical vehicles spaced at equal intervals is considered and the driver of each vehicle is assumed to respond to a given signal in an equal time.

NOTATION

M mass of vehicle in slugs
R rate at which vehicles pass a given section on the road in vehicles per sec.
P point on the road (see Fig. 1)
S stopping distance in ft
V vehicle speed in ft per sec
a distance between moving vehicles in ft
g gravitational acceleration (32·17 ft per sec^2)
l length of vehicle in ft
t time in sec
x cartesian coordinate in ft
μ coefficient of friction between vehicle and road

Suffixes

B braking distance
O optimum value
T thinking distance

STOPPING DISTANCE

The stopping distance[1] is made up of two parts: first the distance a vehicle travels during the time interval between the driver observing a stop signal and actually applying the brakes; and secondly, the distance travelled during which normal braking takes place.

THINKING DISTANCE

If the time interval for the first part of the stopping distance is regarded as a constant "thinking time," then the "thinking distance" will be given by the expression

$$S_T = V\,t_T \quad . \quad . \quad . \quad (1)\,(a)$$

The figures given in the *Highway Code* table correspond to a thinking time t_T of 0·682 sec, that is,

$$S_T = 0{\cdot}682\,V \quad . \quad . \quad (1b)$$

BRAKING DISTANCE

When the brakes are applied it is assumed that all the wheels lock and sliding takes place. If the vehicle has a mass M slugs the equation of motion is

$$M\ddot{x} = -\mu M g$$

therefore

$$\frac{\dot{x}^2}{2} = -\mu g x + \frac{V^2}{2}$$

(where V is the vehicle speed before the brakes are applied).

The braking distance will be given when

$$\dot{x} = 0 \text{ and is}$$

$$S_B = \frac{V^2}{2\mu g} \quad . \quad . \quad (2a)$$

The figures in the table[1] correspond to a coefficient of friction μ of 0·67, that is,

$$S_B = 0{\cdot}0232\,V^2 \quad . \quad . \quad (2b)$$

which corresponds to a constant deceleration of 0·67 g.

Hence, the total stopping distance may be expressed by the following equation

$$S = S_T + S_B = V\,t_T + V^2/(2\mu g) \quad . \quad (3)$$

which, with values for t_T and μ in agreement with the *Highway Code*, becomes

$$S = 0{\cdot}682\,V + 0{\cdot}0232\,V^2 \quad . \quad (3a)$$

LINE OF TRAFFIC

Consider a line of identical vehicles of length l moving at a velocity V at a distance a apart. If one vehicle in the line suddenly receives a stop signal it will travel a distance S_T before its brakes are applied. The application of the brakes will illuminate the rear stop light and therefore give a stop signal to the vehicle immediately behind. The distance-time history for such a line of traffic is shown in Fig. 1. This diagram corresponds to a Characteristic Position Diagram used in unsteady flow problems. The analogy is illustrated in Fig. 1 by the comments shown in parentheses.

In the diagram the stop signal is illustrated by an asterisk. From the geometry of the diagram, when the vehicles come to rest they are separated by a distance $(a - S_T)$. It is necessary for this quantity to be a positive number if the vehicles are to come to rest without colliding with one another.

There is, however, another important spacing which concerns traffic safety; this is slightly more involved than that above and is as follows. The distance between the rest position of vehicle No. 1 shown in Fig. 1 and the point P on the road occupied by the vehicle No. 0 immediately in front of vehicle No. 1 at the instant the stop signal occurred is $(a - S_T - S_B)$.

This spacing covers the situation where vehicle No. 0 stops almost instantaneously at point P; this effect could be caused by a sudden tyre blow out, loss of a wheel, or part of a load falling into the roadway at point P. The

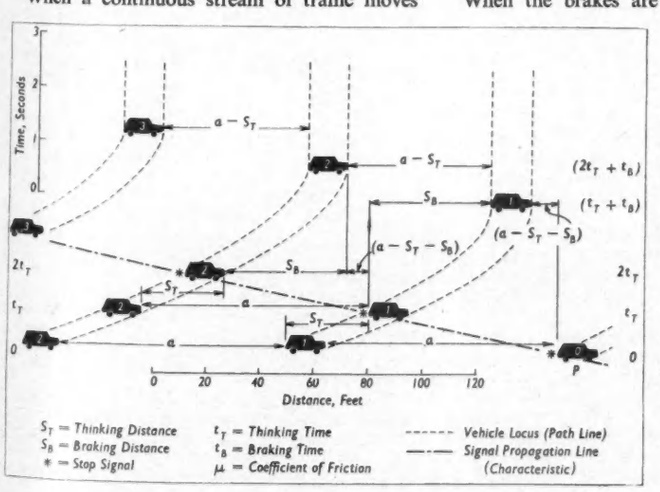


Fig. 1 (left) Distance-time history diagram for a line of traffic. It is based on 15 foot long vehicles travelling at 30 mph and for $t_T = 0{\cdot}682$ sec and $\mu = 0{\cdot}67$.

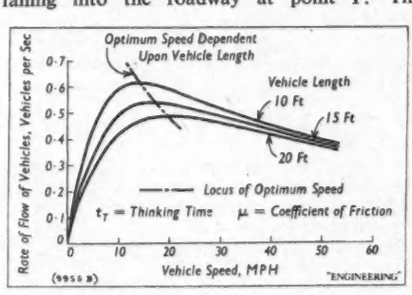


Fig. 2 (right) Curves for rate of flow against speed, showing vehicle-length effect.

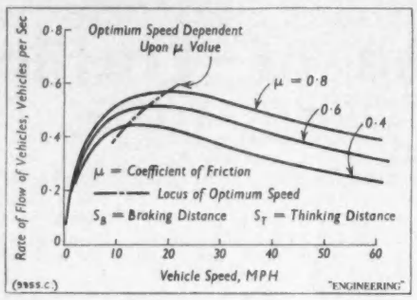


Fig. 3 Curves for rate of flow against speed, showing coefficient-of-friction effect.

required condition is that vehicle No. 1 shall not collide with the obstruction now situated at P. If the quantity $(a - S_T - S_B)$ is a positive number then vehicle No. 1 comes to rest in front of the obstruction.

Hence, the spacing required depends upon (*a*) the type of stop signal the line of traffic must be able to respond to and (*b*) the final spacing which is required.

STOPPING REQUIREMENTS

The first stopping requirement is the most stringent and is dictated by vehicle No. 1 as explained above. The minimum spacing for this condition is given by the equation

$$a = S_T + S_B \quad . \quad . \quad (4)$$

This will now be considered as a " safe " spacing but its limitations will be discussed later by examining the importance of thinking time and coefficient of friction. The second requirement covers the case in which an overshoot by vehicle No. 1 can be tolerated and also that in which the vehicles come to rest bumper to bumper. In this case,

$$a = S_T \quad . \quad . \quad . \quad (5)$$

The above two cases are concerned with vehicle spacing equal to (1) the stopping distance $S_B + S_T$ and (2) the thinking distance S_T. It is also of interest to examine a situation in which the vehicle spacing is equal to the braking distance. In this case,

$$a = S_B \quad . \quad . \quad . \quad (6)$$

RATE OF VEHICLE FLOW

With a vehicle spacing as given by equation (4) and the values of t_T and μ consistent with the Highway Code figures the length of the roadway associated with one vehicle is,

$$l + 0{\cdot}682V + 0{\cdot}0232V^2$$

Hence, the rate at which vehicles pass a given section of road is

$$R = \frac{V}{l + 0{\cdot}682V + 0{\cdot}0232V^2} \text{ vehicles per sec.} \quad (7)$$

It is interesting to note that there is a certain vehicle speed for the maximum flow rate. By differentiating and equating to zero the optimum speed is found to be

$$V_0 = 6{\cdot}56\sqrt{l} \quad . \quad . \quad . \quad (8)$$

Thus the larger the vehicle the higher the optimum speed, but the rate of flow of vehicles is reduced as illustrated in Fig. 2. Hence, the rate of flow of vehicles at the optimum speed may be expressed in terms of the vehicle length as follows,

$$R = \frac{3{\cdot}280}{\sqrt{l} + 2{\cdot}235} \quad . \quad . \quad . \quad (9)$$

Hence, the optimum rate of flow increases as the vehicle length is decreased, and, in the limit, as the vehicle length approaches zero the flow rate approaches

$$\lim_{l \to 0} (R) = 1{\cdot}468 \text{ vehicles per second.}$$

Equation (7) is shown graphically for three lengths of vehicle in Fig. 2.

With the second type of spacing, given by equation (5), the flow rate is

$$R = \frac{1}{l/V + 0{\cdot}682} \quad . \quad . \quad . \quad (10)$$

It is noted that in this case there is no optimum speed.

As the speed becomes very large the flow rate asymptotically approaches 1·468, the same value as given above. This time, however, it is applicable for a finite vehicle length.

Finally, if the vehicles are spaced according to the braking distance as given by equation (6) the rate of flow becomes

$$R = \frac{V}{l + 0{\cdot}0232V^2} \quad . \quad . \quad (11)$$

In this case there is an optimum speed which is the same as that given by equation (8). The distance between two adjacent vehicles after they have stopped is shown in Fig. 1 to be $(a - S_T)$. Hence in this case a condition must be imposed that

$$(a - S_T) \geqslant 0$$

therefore

$$S_B - S_T \geqslant 0$$

before equation (11) is valid. In order to complete the analysis it is necessary to examine the effect of a change in μ and t_T.

VARIATIONS OF COEFFICIENT

By considering equation (3) in place of (3a), equation 8 becomes,

$$V_0 = \sqrt{2\mu g l} \quad . \quad . \quad (12)$$

This equation reveals two important facts: first, that the optimum speed is independent of thinking time, and, secondly, that the optimum speed depends upon the square root of the coefficient of friction between the vehicle and the road. These two facts and the general effect of changes in coefficient of friction and thinking time are illustrated graphically in Figs. 3 and 4.

FLOW RATE AND SPACING

First, it should be pointed out that it has been implied that equations (1b), (2b) and (3a) are valid for speeds below the range covered in the table.[1] Since these equations were derived on the basis of simple dynamics this implication appears reasonable.

The results shown in Fig. 2 show that for full stopping distance spacing there is a definite speed which corresponds to a maximum vehicle flow rate. The optimum speed is surprisingly low, about 17 mph for a 15 ft vehicle. In addition, it is seen that the flow rate is higher for vehicles of small length.

It is of interest to note that the maximum speed limit in the fast lane of the Mersey Tunnel 30 mph, and that drivers are instructed to keep 75 ft from other vehicles. This is consistent with the *Highway Code* figures and a full stopping distance spacing. Hence, on this basis it seemed reasonable to apply the ideas previously developed to the problem of the Mersey Tunnel traffic.

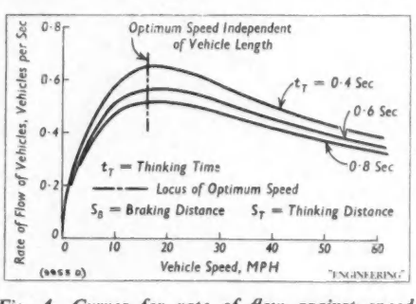


Fig. 4 Curves for rate of flow against speed, showing thinking-time effect.

If an average vehicle length for the present tunnel traffic is assumed to be 15 ft, from Fig. 2 the maximum vehicle flow rate is approximately 0·54 vehicles per second. Supposing the tunnel was restricted to small cars, such as the BMC Mini-Minor, having a length of approximately 10 ft, the maximum flow rate would be about 0·62 vehicles per second, an increase in flow rate of approximately 10 per cent.

The results shown in Fig. 4 show that the optimum speed is independent of thinking time but equation (3) shows the full stopping distance spacing to increase with an increase in thinking time. This may be interpreted in two ways.

First, a driver who realises that he has a slow thinking time should ensure that there is an adequate space between his vehicle and the vehicle immediately in front of him; this is a factor which is within the said drivers control. The important point is that one driver with a slow reaction time need not reduce the speed of a line of traffic.

Alternatively, if the stop light of a vehicle were inoperative the effect would be similar to an increase in the thinking time of the driver of the vehicle immediately behind the faulty brake light. In this case the recommendation is that every driver should try to ascertain if the stop light is in working order on the vehicle in front or assume it is faulty and adjust his spacing accordingly. In the case of the Mersey Tunnel the stop light operation may readily be observed just prior to entering the tunnel.

The curves shown in Fig. 3 illustrate the importance of the coefficient of friction.

The coefficient of friction consistent with the Highway Code figures, which apply to " good braking " conditions, appears, at first sight, somewhat low. This result may be explained by the fact that the simple theory presented in this article neglects the inertia of the road wheels and engine parts and also the fact that the wheels do not lock immediately the brakes are applied. However, the general trend in the effect of a variation of coefficient of friction is revealed by the simple theory. It should be appreciated that other charts similar to Fig. 2 may be constructed for different values of coefficient of friction, for example, a chart for wet weather conditions.

REFERENCES

[1] *The Highway Code.* HM Stationery Office.

[2] Lighthill, M. J., and Whitham, G. B. " On Kinematic Waves. II: A theory of traffic flow on long crowded roads." *Proc Royal Soc. Series,* A, No. 229 (1955), p. 317.

[3] Greenshields, B. D. " A Study of Traffic Capacity." *Proc. Highway Research Board,* vol 14 (1935), p. 468.

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[6] Smeed, R. J., and Bennett, G. T. " Research on Traffic Flow and Road Safety." Institution of Civil Engineers Road Engineering Division Paper No. 29 (1949).

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Human Element

Joint Committee on Saving Manpower

PARTICULAR attention is to be paid by the committee considering how wasteful misuse of labour in industry can be avoided to the four points put forward by the British Employers' Confederation at the recent National Joint Advisory Council's meeting. The joint union and employers committee was agreed upon at that meeting.

The BEC's four points were that employers need encouraging to make the best use of labour and not to hold on to skilled men, keeping them on prolonged short time when they are much needed by other companies; that training should improve the versatility of workers, broadening the basis of their security and status beyond that given by one specialized skill; that provision should be made for training older workers who have to move from their jobs, and that there should be greater efforts to acquaint workers with the benefits to them of technical progress in industry.

Training for New Jobs

The NJAC, which is made up by representatives of the employers, the nationalized industries and the unions, presided over by the Minister of Labour, went on to approve a Ministry of Labour document on redundancy which will appear shortly. Both the employers and the unions asked that the Ministry should give more information on the exact nature of the 340,000 unemployed and on the more problematical question of the extent to which the reabsorption into industry of workers displaced by technological change could be assisted by training.

From the employers' side it was suggested that more detailed information on the pool of unemployed workers would help in evaluating the measures required to get them into jobs, as a separate issue from national monetary decisions.

The BEC took the opportunity of the meeting to ask Mr. John Hare, the Minister of Labour, to inform the Chancellor of the Exchequer, Mr. Selwyn Lloyd, that they do not believe the more efficient use of manpower will be assisted by the payroll tax proposed in the Budget.

Extra Cost Inquiry for New Town Site

Due to the many old mine workings in the area, a special investigation is to be made for the Ministry of Housing and Local Government of the possibility of building a new town in the Dawley area of Shropshire, and of what the probable extra cost may be.

The Housing Minister, Mr. Henry Brooke, has had the possibility of a new town in the Dawley area, to take "overspill" from Birmingham and the Black Country, under review for some months.

The investigation is to be carried out by Mr. A. G. Sheppard Fidler, the Birmingham City Architect, who will be acting for the Ministry of Housing on this occasion and not for the Birmingham City Council. Special assistance is to be provided from the Ministry and other sources on subsidence and reclamation questions.

Shropshire County Council and five rural district councils in the area have been informed by the Ministry, which is seeking their cooperation.

Echoes of Price Fixing Convictions in USA

The depth and strength of the effects produced by the convictions for price rigging in the United States of a number of electrical company executives is only slowly making itself apparent.

Appearing before a Senate investigating committee one of the company's executives, who was both fined and imprisoned and later sacked by General Electric, stated that Mr. Ralph Cordiner, GEC's chairman, knew in 1952 that company officials were agreeing with competitors to fix prices.

In reply, Mr. Cordiner described this statement as an outrage and that any charges that he had known of, or condoned, a violation of anti-trust laws were untrue. The General Electric chairman hopes to be given the opportunity to "testify" and he intends then to answer any allegations.

Another opportunity to testify is being given by the Senate investigating committee. It is to Mr. Robert Paxton, a former General Electric president who was also named in the evidence of the gaoled former executive.

After the statements to the investigating committee came a meeting of company shareholders, held in Syracuse, New York. Mr. Cordiner said that he was grieved by the injury done to the company by the recent court decision.

The President of the Federation of Women Shareholders in American Business, Miss Wilma Soss, suggested that Mr. Cordiner should resign. When Mr. Cordiner refused, saying that he was innocent, Miss Soss rejoined that innocence or guilt made no difference; the point was that Mr. Cordiner was an embarrassment.

Mr. Cordiner and his colleagues on the board were later given an overwhelming vote of confidence and re-elected.

From Radar to Further Education

The first director of the proposed new Staff College for Further Education is to be Mr. W. J. Richards, the director of the Royal Radar Establishment, Malvern.

The aim of the new Staff College will be the bringing together of principals and other key staff from colleges of technology and commerce in order to exchange ideas and experience with senior staff from industry, local and central government and universities at home and overseas jointly to study the ideas and growth of education, bearing in mind the swift changes in technology and science.

An independent self-governing institution, the College's governing body represents both educational and industrial interests. Its chairman is Lord Fleck, former chairman of ICI.

Before the first director can pick himself an office he will first have to find the college a suitable home. Search is being made, chiefly in the Midlands, for suitable premises around which to develop the Staff College.

Mr. Richards, 57 years old, is a first class honours graduate in engineering from Manchester University. After some years of research and development at the Royal Aircraft Establishment, Farnborough, he became deputy director of scientific research at the Ministry of Aircraft Production in 1942. He has occupied his present position at Malvern since 1953.

New Chairman for Research Council

Sir Harold Roxbee Cox, one of the pioneer workers on jet propulsion and on engineering problems in gas-turbines and in fuel and power, is to be chairman of the Council of the Department for Scientific and Industrial Research. Sir Harold's five year term, in succession to Sir Harry Jephcott, chairman since the founding of the Council, begins in October.

A professional engineer, Sir Harold joined the Austin Motor Company from Kings Norton Grammar school and during this period gained first class honours in mechanical engineering. After studying aeronautics at the Imperial College of Science and Technology he worked from 1924 to 1929 on the construction of the airship R 101. When the airship programme was abandoned in 1931 Sir Harold spent four years at the Royal Aircraft Establishment investigating wing flutter and stability of structures.

Appointed head of the Air Defence department in 1936, by 1938 he had joined the Air Registration Board as chief technical officer.

Work with Whittle

At the Ministry of Aircraft Production in 1940, under Lord Beaverbrook, he became Deputy Director of Aircraft Research and Director of Special Projects three years later. This was the period of close collaboration with Sir Frank Whittle on the jet engine and in 1944 he took up the position of chairman and managing director of Power Jets (Research and Development) Limited. Two years later Sir Harold became the National Gas Turbine Establishment's director and after another two years Chief Scientist of the Ministry of Fuel and Power.

Leaving the Government's service for industry in 1944, Sir Harold Cox had by 1957 joined the board of the Metal Box company, becoming deputy chairman in 1959 and chairman in January of this year.

Actively concerned in technical education, he is chairman of the National Council for Technological Awards and vice-chairman of the Governors of the College of Aeronautics, as well as a vice-chairman of the Council of the Air Registration Board.

Keele to Seek University Status

Ten years after its opening the University College of North Staffordshire is to ask for university status.

Sponsored by Oxford, Manchester and Birmingham universities, Keele has from the start been able to award its own Bachelor's degree. The attempt by Keele to maintain breadth and diversity in its four-year course, the humanities being studied alongside scientific subjects, has attracted constant interest and scrutiny.

Princess Margaret, who is president of the University College, speaking at a recent ceremony commemorating the opening of the college by her mother, Queen Elizabeth the Queen Mother, ten years ago, said that no university had in its first decade built both for residence and for teaching, as had been done at Keele. The University College's sponsors believed that they had "learned sufficient wisdom" to be allowed to petitition the Queen through the Privy Council for a charter as a full university in 1962.

A Gift from Engineers in Guildford Cathedral

The cost of Guildford Cathedral, in Surrey, to be consecrated on Wednesday (17 May), has been generously contributed towards by the doctors, lawyers architects, teachers and other professional groups in Surrey and beyond.

Donations from engineers, which will, it is hoped, pay for the three arches over the West Gallery, have so far reached £900 of the target figure of £1,500.

Guildford Cathedral is one of the only two new English cathedrals on a new site to be built in the last 500 years and there will be many engineers who would wish their profession to share with others in meeting some of the cost.

The remaining £600 still needs to be subscribed and donations may be sent to Dr. Percy Dunsheath, at Guildford New Cathedral Council, Diocesan House, Quarry Street, Guildford, Surrey.

Lancaster Site for New University

The new university in the North West is to be near Lancaster, at Bailrigg, a 200 acre estate at present the home of a motor factor.

The committee choosing a site to recommend to the Univeristy Grants Committee had four alternatives before them, two 200 acre sites at Blackpool, the Royal Albert Hospital, Lancaster, and the Bailrigg mansion and estate.

In picking Bailrigg, among other reasons, for Lancaster's long cultural tradition, the committee decided that the Royal Albert, a former mental hospital, was not suitable for the development of the new university.

Support for the new university has been declared by a number of major companies, through the Federation of British Industries.

Given approval by the University Grants Committee, it is expected that within five years the university will be open for some 1,000 students, increasing to a total of about 5,000.

Skelmersdale New Town Public Inquiry

Sir Richard Manktelow, who retired last year as deputy secretary of the Ministry of Agriculture, Fisheries and Food, has been appointed by the Minister of Housing to preside over a public inquiry into objections to the draft order designating 4,029 acres of land at Skelmersdale, Lancashire, as the site of a new town.

The inquiry, to be held at the Skelmersdale Town Hall, on 31 May and 1 and 2 June, will if necessary be continued on 6, 7 and 8 June.

Failure Mechanism of Saturated Concrete

Most concretes in practice carry their load in a near saturated condition. The author has investigated the behaviour of saturated concrete at ultimate loads.

By T. N. W. Akroyd, M.Sc. (Tech.), LL.B., A.M.I.C.E.

Constructional Services Limited

In the last few years a number of articles and papers have been published concerned with the behaviour of rocks and concrete at failure. Much of the work has been carried out in the United States but increasing attention is being given to the problem in this country. One of the basic tests used is the triaxial compression test, in which axial compression induces failure in a cylindrical specimen while it is, at the same time, supported by lateral hydraulic pressure. The use of such a test follows from the analysis of the theory of failure by Mohr, and the results of the test are plotted as Mohr "circles" (see Fig. 1 for example).

The purpose of the triaxial test is to determine the behaviour of the material under controlled conditions so that from the test results the state of stress and the behaviour at failure can be determined. For satisfactory results it is necessary to use lateral hydraulic pressures of the same order as the unconfined compressive strength, so that for rocks and concrete this means a lateral pressure up to 10,000 lb per sq. in. Over the past two years the author has had operating a triaxial machine designed for hydraulic pressures of 20,000 lb per sq. in in which specimens up to 3 in diameter and 6 in long can be tested.

Tests have been carried out on a number of rocks, but in the first instance particular attention has been given to testing concrete. The behaviour of concrete under triaxial loading was investigated, probably for the first time, by Richart *et al.*[1] at Illionois over 30 years ago, this work was later extended by Balmer[2] (in 1949) using what is probably the world's largest triaxial testing machine.

From these results we know that the effect of lateral pressure is to increase the vertical stress at failure by an amount equal to about seven times the lateral pressure supporting the sample. This effect occurs at small lateral pressures but as the lateral pressure is increased the increment in the vertical stress is proportionally less, gradually falling off until at large lateral pressures the increment in the vertical stress is only about three times the lateral pressure. The tests which established these facts were all carried out on concrete which had been dried in an oven for a week before test. But, of course, most concrete is not dry and much is saturated, yet no tests appear to have been published of work carried out on saturated concrete.

There are two ways in which the test can be performed; the test specimens may be covered in a jacket or membrane to prevent the cell fluid entering the sample and preventing any change in the total moisture content of the sample—this is the undrained test—or the sample may be exposed to the penetrating effect of the cell fluid so that the pressure of the liquid in the cell and the water in the concrete should be at the same value. These two ways do not give the same results and the results they do give are entirely different to the results which are obtained on dry concrete. All this is due entirely to the water content of the concrete and the pressures generated in the water in the pores of the concrete.

Fig. 1 (*a*), (*b*) and (*c*) give some typical results for tests on jacketed samples, with no change in water content. Fig. 2 is the result of a series of tests on unjacketed samples. The tests on the jacketed samples show that the concrete fails at a much lower load than might be expected from tests on dry concrete and, instead of the axial load increasing proportionally to the lateral pressure, it reaches a maximum of about three times the unconfined compressive load. This is not the kind of behaviour one would immediately expect from a brittle material reputed to depend for its strength upon cohesion and internal friction.

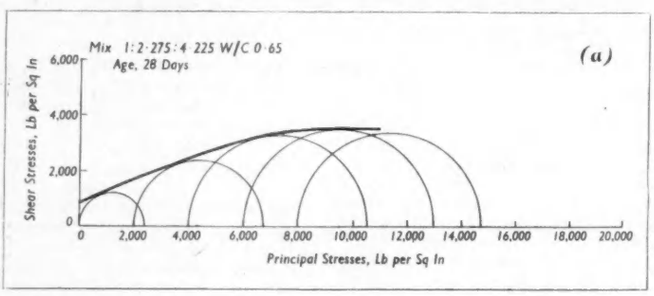
The behaviour is reminiscent of that of a saturated clay tested in a similar manner. In fact, in soil mechanics terminology, the concrete fails as a $\phi = 0$ material, where ϕ is the angle of internal shearing resistance. The limiting lateral pressure, above which a $\phi = 0$ case is found, seems to depend upon the unconfined compressive strength of the concrete and may also depend upon the density.

Tests on the unjacketed specimens do not give a $\phi = 0$ result; the strength of the specimens increases slightly on what may well be a straight line increase after an initial more-rapid increase in strength (see Fig. 2).

In neither series of tests is the mode of failure other than what one would expect from the failure of a brittle material. The failure is sudden and rapid and is accompanied by a dull thud. Some specimens showed a number of conjugate planes of failure and some conical ends, but usually three-quarters of the specimen shattered, leaving a rough conical shape at one end. Unconfined tests often resulted in vertical splitting of the whole specimen, a result which seldom occurred when the specimens were laterally supported. Apart from this, no difference in failure shape has been noted between jacketed and unjacketed tests, or for samples tested at low or high lateral pressures; and, for that matter, no difference has been detected in the manner of failure of samples tested dry, partially saturated or completely saturated (see Fig. 3).

Apart from the difference in actual load at failure between saturated jacketed and non-jacketed tests the main difference in results is that when the sample fails as a $\phi = 0$ case there is a much wider scatter of results, rather as if a bursting force within the sample became operative and initiated failure through any weak spot within the concrete—a condition which does not operate with dry samples or samples tested at low confining pressures.

The cause of this may be that when fully compacted and saturated concrete deforms, it tends to dilate and this increases the volume of the pores and, at low confining pressures, reduces the pore-water pressure to a negative or suction



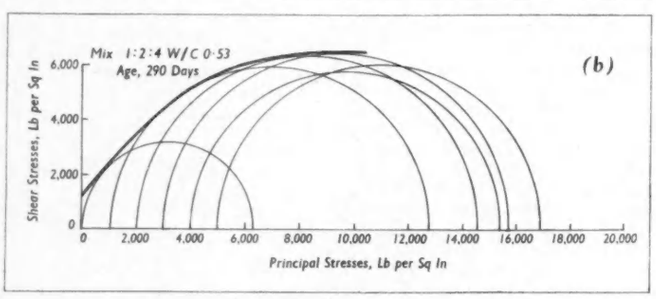
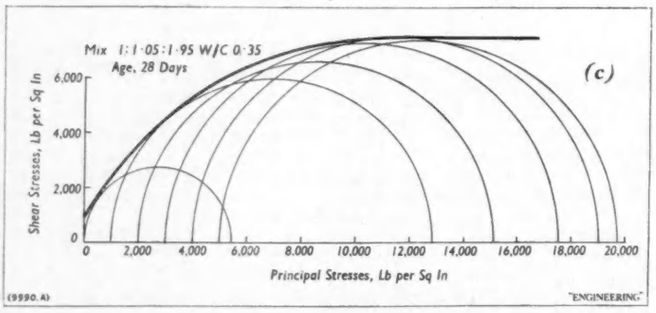
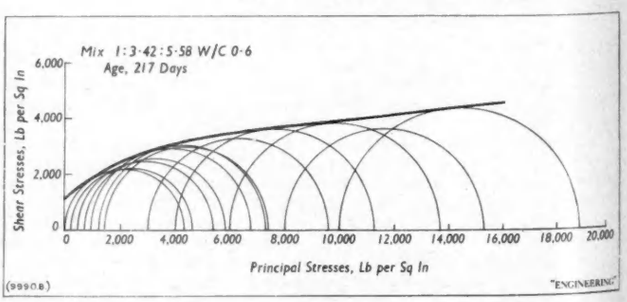


Fig. 1 (a, b and c) Triaxial tests on saturated jacketed specimens. All specimens were 3 in diameter cylinders, 6 in high, made with ¾ in Thames Valley aggregate and ordinary Portland cement.

Fig. 2 (below) Triaxial tests on saturated unjacketed specimens. The specimens and mix are as described for Fig. 1.





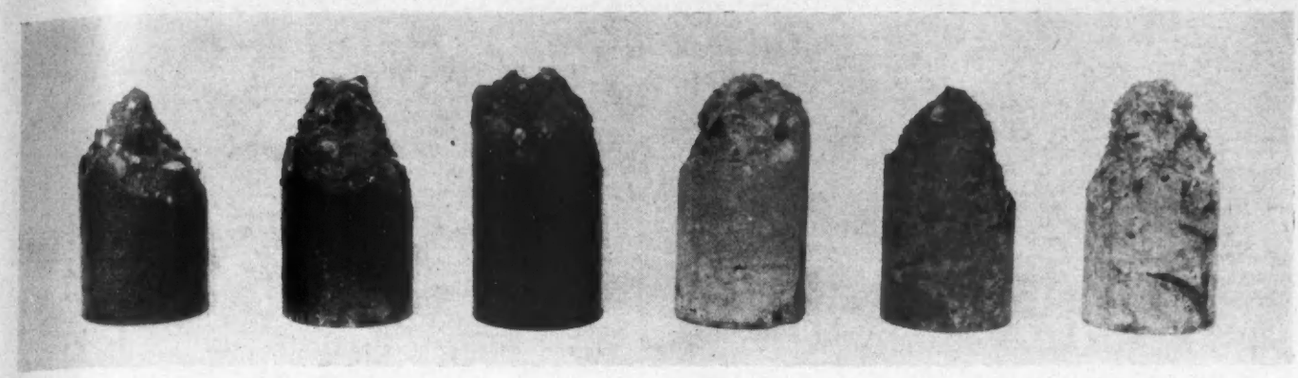


Fig. 3 Cylinders after test. Three on the left were tested jacketed at 2,000, 4,000 and 6,000 lb per sq. in. Three on right tested unjacketed at same pressures.

value. At low lateral pressures this would assist the intrinsic cohesive force of the cement gel in holding the concrete together. As the lateral supporting pressure increases, the pore-water pressure will not become negative. But it is probable that no concrete is ever fully saturated because during hydration the tiny capillaries in the cement gel, which are at first full of water, are partially emptied as a result of the hydration process itself. These capillaries do not readily refill with water even when the concrete is cured under water.

When high pore water pressure is generated in the larger pores, a very high hydraulic gradient will exist in the fine capillaries in the cement gel, in consequence of which the concrete may actually fail by bursting in a manner typical of the failure of saturated concrete when subject to freezing. What is abundantly clear, however, is that much work yet remains to be done before we can be sure of the exact mode of failure of saturated concrete.

Acknowledgments.—The results of the triaxial tests are quoted by permission of the directors of Constructional Services Limited, 123 Victoria Street, London SW1, and form part of a series of high pressure triaxial tests on non-metallic brittle materials.

References

[1] Richart, F. E., Brandzaeg, A., and Brown, R. L. *A Study of the Failure of Concrete under Combined Compressive Stresses.* Univ. of Illin. Bull., No. 185, 1928.

[2] Balmer, G. G. *Shearing Strength of Concrete under High Triaxial Stress.* Struct. Res. Lab. Rep. No. SP-23, 1949.

Rapid Analysis of Freshly Mixed Concrete

By C. D. Turton, B.Sc.

John Laing
Research and Development Limited

Although every care should be taken to ensure that a concrete mix is correctly designed for any particular set of circumstances, and that batching is carried out accurately, the possibility of an error occurring at some stage must always be guarded against. It is for this reason that cubes are normally made as the work proceeds, and are tested after curing for 7 and 28 days under standard conditions.

To overcome the need for waiting so long before the quality of the concrete is known, various means whereby results at these ages might be anticipated have been investigated. Most of these are based on the accelerated curing of the concrete at elevated temperatures and take between 6 and 24 hours.

"Wet analysis," or the breaking down of concrete into its constituent materials before hardening commences, has been advocated as a control over the quality of concrete which might well dispense with a great deal of testing of concrete cubes which specifications currently demand.* It is suggested that provided the constituent materials are present in approximately the designed proportions and that workability is correct for the method of placing, then very few of the faults which so often beset concrete production, would be manifest.

A method of "wet analysis" is given in BS 1881: 1952, "Methods of Testing Concrete," but it is somewhat complicated and takes up to an hour to perform. The cement is first removed by thoroughly washing the sample over a suitable series of British Standard sieves, the finest being a No. 100. Knowing the specific gravities of each of the retained fractions, their dry weights are then deduced after weighing in open buckets under water.

In the British Standard method, the weight of cement must be obtained by difference, which means that errors in obtaining the weight of aggregate can seriously affect the calculated aggregate/cement ratio.

The writer has overcome this difficulty by the use of a simple piece of apparatus which enables the weight of cement as well as aggregate to be obtained directly. It consists of a robust non-ferrous metal container of about 4 gallons capacity, designed to measure a fixed volume of water with a high degree of accuracy. This is done by locating the end of a small syphon tube in the centre of the neck of the container, as shown in the diagram. The wet sieving of the concrete is done over this container and when all the material, mainly cement, passing the No. 100 sieve has been collected, the water level is raised to just above the syphon tube, and then reduced to the pre-determined level by syphoning. The container is weighed on a balance reading to about 0·005 lb, and the dry weight of the cement, and of all the other fractions which are similarly weighed in turn, is obtained by multiplying the weight under water by the factor F, where

$$F = \frac{\text{Specific gravity of the fraction}}{\text{Specific gravity} - 1}$$

The amount of silt passing the No. 100 sieve and the amount of cement retained on it are determined by preliminary tests on the unmixed materials.

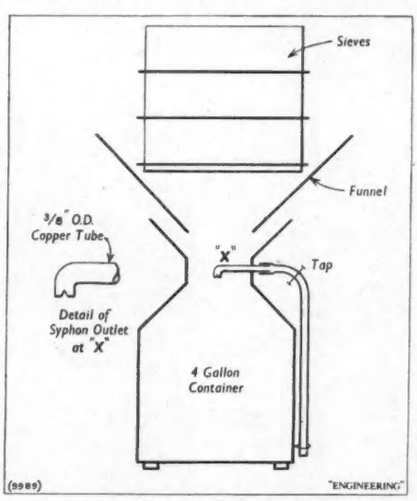


Diagram of apparatus.

Tests to determine changes in silt contents of gravel aggegates or the amount of dust (−100 mesh) on crushed aggregate at the time of batching should be carried out at intervals. With crushed rock aggregates the dust content may vary slightly according to whether they are dry or damp.

Rather more care is necessary in sampling concrete for "wet analysis" than for making compression test cubes. This is because the variation in aggregate to cement ratio from point to point in a batch of concrete is normally greater than the variation in the water to cement ratio which is the primary determinant of strength. With concrete using a rounded or partly rounded aggregate of ¾ in maximum size, a sample of 12 lb to 15 lb weight is adequate. With a rough textured aggregate of this size or when using 1½ in aggregate, a larger sample should be taken.

The separation of cement from an aggregate such as a limestone is greatly facilitated by vigorously agitating the concrete with water in a strong polythene bag prior to sieving. With these precautions, the aggregate to cement ratio can be determined to within ± 2 per cent.

The increased accuracy of this method over the BS method is clearly shown by considering the effect of an error of −1 per cent in the aggregate determination. In a 6 : 1 mix a 1 per cent error represents 0·06 parts, and in the BS method these are lost to the aggregate and automatically added to the cement, giving an aggregate to cement ratio of 5·94 : 1·06 or 5·6 : 1, which is in error by 6·6 per cent. By measuring the weight of cement directly in the way described, a 1 per cent error in the aggregate determination gives a 1 per cent error in the aggregate/cement ratio.

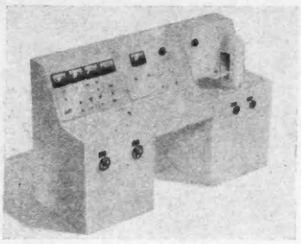
With one operator, the test can be completed in 10 to 20 minutes from the taking of the sample, depending on the texture and maximum size of the aggregate. The method is being used, with very satisfactory results, for controlling the quality of concrete from continuous proportioning and mixing plant.

Development work is in hand with the object of reducing the size of the equipment required.

* Fisher, Lee and Millard, "Research and its Application to Road Construction." *Proceedings Inst.C.E.*, Vol. 12, April, 1959, p. 417.

ZONE REFINER

For Semi-Skilled Operators



THE Mark II zone refiner will accommodate specimens up to 8 in in length.

The instrument is a development of the original design by the Services Electronics Research Laboratory and has been simplified as far as possible with the object of making it usable by semi-skilled labour, and of reducing maintenance. A small power input and a narrow molten zone are other features.

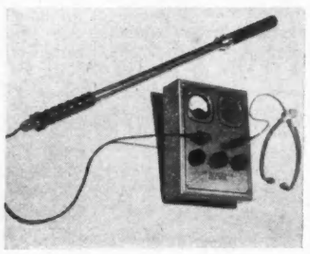
The high voltage system consists of a half-wave rectified 50 cycle transformer delivering 10 kV maximum at 500 mA. The extra high tension (eht) and the filament source are controlled by Variacs on the left side of the console. An emission stabilizer is incorporated to reduce the filament temperature when outgassing of the specimen is liable to cause sparkover.

A mercury diffusion pump with a liquid nitrogen trap is used to avoid contamination by hydrocarbons. A pumping speed through the baffle of 150 litres per second will cope with most specimens, though those of low initial purity should be avoided owing to the liability of contaminating the chamber. Working pressures down to 10^{-6}mb can be obtained.

The working chamber is covered by a "hat" which can be removed to give access to all parts. It incorporates a jacket for water cooling. The traversing lead screw is water cooled and the speed can be adjusted during zoning from zero to 350 cm per hour. The protective shutters over the viewing window can also be opened during operation for observation of progress. *Miles Hivolt Limited, Old Shoreham Road, Shoreham-by-Sea, Sussex.*

INDUCTION TRACER

For Pipes and Cables



FOLLOWING the paths of cables and pipes and locating faults in them can be carried out with the induction tracer type 660, as illustrated.

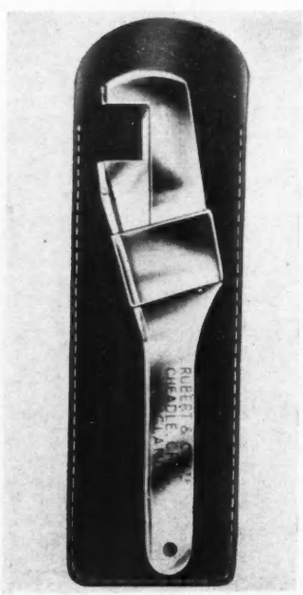
The instrument is portable and highly sensitive. In use an alternating current is injected in at one terminal of the wire cable or pipe line under test. This gives rise to an alternating magnetic field surrounding the conductor concentrically. If the probe of the tracer is then placed in the field, an emf will be induced in the coil and after amplification in the receiver an audible signal as well as a meter indication is obtained enabling the operator to follow with ease the path of the injected pilot current.

The instrument is self-contained and is fully transistorized. It is powered by two standard batteries. A linear or a selective response may be obtained by setting a selector switch; in the latter case extraneous interference is largely eliminated. The audible signals are reproduced by loudspeaker, or by stethoscope ear phones for noisy locations, and their magnitude is shown on the meter. The pilot current may be obtained from an electronic oscillator for which a battery and mains operated unit is available. Alternatively an interrupter or buzzer may be used.

The probe is supplied with a 5 ft coaxial lead and plug. The receiver measures 7 in by 8¼ in by 2½ in and weighs 5 lb. A leather carrying case is available. Alternative probes are an electrodynamic acoustic type to locate discharges, and a capacitive probe for close tracing work and the identification of individual cores of telephone cables. *Addison Electric Company Limited, 10-12 Bosworth Road, London W10.*

ADJUSTABLE SPANNER

Wedge Action



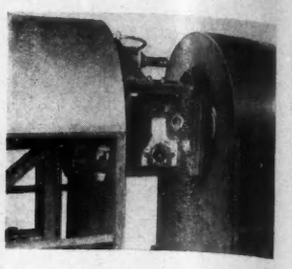
A SIMPLE wedge action is the principle of the adjustable spanner shown in the illustration.

The whole tool consists of three parts only; the base member comprising the handle, two angular slides and one jaw; the second jaw which slides on the base member; and the sleeve which holds the two together. The sliding jaw is connected to the sleeve by a spring and is guided by a stud in the body.

By moving the sleeve along the base member by the thumb, the lower jaw will also move and when pressure is applied between the two jaws the wedge will tighten against the sleeve and come to a definite stop. There is no worm gear or screw thread to go wrong and the action is positive, even if wear takes place. The spanner measures 6 in long and 1½ in wide at the jaws. The range of heads that it will accommodate is from $\frac{3}{16}$ in to $\frac{13}{16}$ in across flats (½ in Whitworth). *Rubert and Company Limited, Acru Works, Demmings Road, Councillor Lane, Cheadle, Cheshire.*

CASTING CLEANER

Removes Sand, Shot and Swarf



THE machine in the illustration is designed to remove swarf, sand or shot from castings, by vibration.

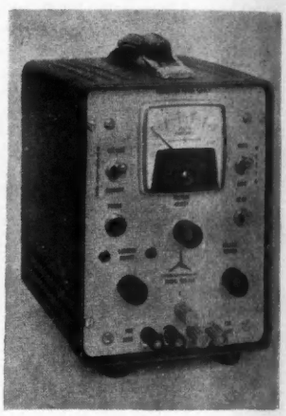
The casting is inserted in a cage where it is automatically clamped by pneumo-hydraulic rams. It is then subjected to vibration while being turned through a circle and back again under the control of limit switches. The rotation is by a reversible geared motor unit and chain drive. The vibration is isolated from the supporting structure by motor tyres inflated to 8 to 10 lb per sq. in, and the stub axle bearings are used to form the axis of rotation.

Two contra rotating rotary electric vibrators are so linked that at 30° from the vertical they impart a conveying action and the cage becomes an orthodox vibratory conveyor. Similarly when inverted and inclined at 30° they become again a conveyor but in the opposite direction so that any loose material remaining receives a strong feeding impulse. In these two positions the vibrators are self synchronising; in all other positions they drop out of synchronism and so subject the cage and casting to a range of frequencies and amplitudes.

The particular unit illustrated is designed for handling a cylinder block casting, but the arrangement is adaptable to other shapes and sizes. The machine can also be used for stress relieving castings or welded structures by vibratory shake-down. However the time cycle for stress relieving is of the order of hours whereas for cleaning, a single rotation with a time cycle of about 30 to 40 seconds is adequate. *Sinex Engineering Company Limited, North Feltham Trading Estate, Feltham, Middlesex.*

TRANSISTORIZED POWER SUPPLY

Close Regulation



THE Trylab series of transistorized power supplies is designed for most general laboratory purposes.

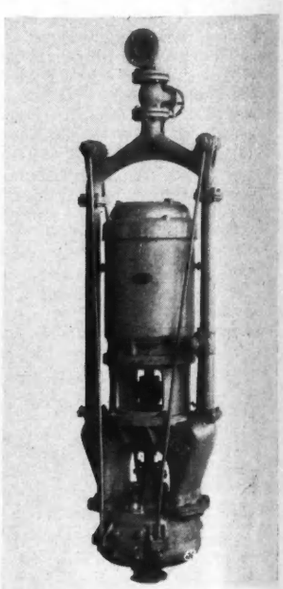
Both voltage and current regulation is better than 0·05 per cent while the voltage ripple is less than 0·5 mV and current ripple less than 0·01 per cent. The model illustrated, T50-750, has an output up to 50 V at 750 mA with an output impedance of 0·015 ohms up to 1 Kc/s, and of 0·05 ohms from 1 kc to 100 kc/s. Recovery time, full load to no load, is 50 microseconds. Models are available for 105-125 V or 200-240 V supplies.

Remote sensing and remote programming over the entire voltage range in the voltage mode, and remote programming over the current mode is included in most models. Adjustable current limiting short circuit protection is provided in all units, ensuring control of the output current under short circuit conditions. For remote programming the rate is 50 ohms per volt over the entire range.

In the constant current mode, voltage compliance is up to 50 V at rated current or up to 70 V at reduced current. Regulation is 0·05 per cent or 250 microamperes. Overall dimensions of the T50-750 are 8 in high by 6½ in wide by 8 in deep. *Rocke International Corporation, 13 East 40th Street, New York, 16, NY, USA.*

VERTICAL PUMP

For Sub-Level Operations



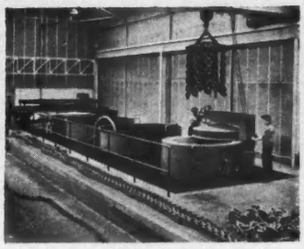
NEW versions of the vertical spindle electrically operated self priming pumps include models with 2 in, 3 in, 4 in, and 6 in suction and delivery sizes.

The pumps are particularly designed for keeping a sub-level floor clear of equipment. They can be mounted some distance above the floor with only a light suction hose reaching the sump.

A totally-enclosed fan-cooled weather-proof high-starting torque low-starting current induction motor operating on 400-440 V 3 phase 50 cycle supply is direct coupled to the pump spindle. Self-priming is achieved by the recirculation method. The unit is slung in a cradle formed by the twin delivery branches which unite above the motor. The impeller is the open type allowing slurries to be handled, and the volute is fitted with renewable wearing plates. Capacities of the 2 in model are 6,000 gph against a total head of 90 ft, and of the 6 in size 50,000 gph against 70 ft. *Henry Sykes Limited, 53b Southwark Street, London SE1.*

CHAIN TREATMENT PLANT

90 ft Lengths



THE illustration shows part of a plant for hardening, tempering and normalizing chains, as installed by the British Steel Chain Company Limited.

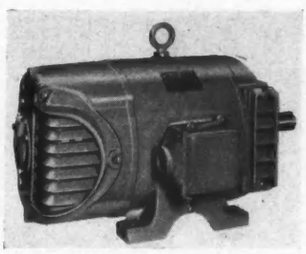
The hardening and normalizing furnace is of the Incandescent pit type arranged for towns gas firing using radiant bowl burners. It is suitable for operating in the temperature range from 700 to 950° C. Uniform temperature conditions through the heating chamber and a high rate of heat transfer with maximum thermal efficiency are claimed. The effective working dimensions of the furnace are 7 ft deep by 5 ft diameter and it will handle chains with a maximum length of 90 ft made of 2 in material and having an approximate weight of 25 cwt.

The combustion system is divided into two zones each having automatic control and recording equipment. The cover or lid is carried on a bogie frame and is raised from the sand seal by hydraulic jacks. Traverse of the lid and supporting frame is effected manually using a hand wheel. The furnace chamber is lined with high temperature refractories backed by solid insulation and enclosed in a circular casing.

Tempering is carried out in a Metalectric electrically heated vertical air circulation furnace of similar dimensions, which is equipped with a swing lid and a simple geared lifting device. This unit is designed for operating accurately at temperatures up to 750° C, and the applied electrical rating of the furnace is 222 kW. The plant is complete with oil and water quench tanks, together with recirculation and cooling devices. *The Incandescent Group, Smethwick, Birmingham.*

SLIP RING MOTORS

Facilities for Double Shaft Extension



NOW AVAILABLE in a limited range are new slip ring motors complying to BS 2613 : 1957 as regards operating performance.

They are available in two types; as continuous rating with drip proof enclosures up to 10 hp 4 pole speed, suitable for applications where the use of squirrel cage motors is not practicable, and for operation on 3 phase 50 cycles supplies; and secondly as KRN class motors suitable for cranes and lifts with ½ or 1 hour rating up to 15 hp 4 pole speed with drip proof or totally enclosed endshields. Both types can be wound for voltages in the range from 100 to 600. Larger frame sizes are to follow, extending the range up to 30 and 40 hp.

Fixing dimensions and shaft sizes conform to BS 2960 : Part I : 1958. The horse power assigned to these frames is one step lower than the equivalent squirrel cage machine listed in the specification.

Features of construction include the employment of internal slip rings which give facilities for double shaft extension machines, and of Class E insulation which permits a maximum temperature rise of 65° C.

Rings and brushes are continuously rated and special attention has been paid to the design of these machines to allow easy accessibility to both the slip and brush gear assemblies for maintenance purposes.

It is intended to complete the range of motors of this class by the development of flanged and skirt-mounted machines which also are constructed to conform to BS dimensions. *Crompton Parkinson Limited, Crompton House, Aldwych, London WC2.*

MOBILE CRANE

5 Ton Capacity

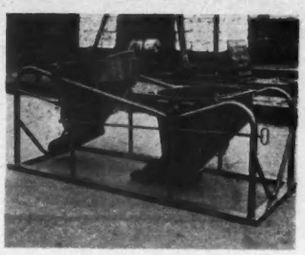
THE Lambert Hydrocon mobile crane has a lifting capacity of 5 tons and a choice of jib lengths up to 56 ft.

The model illustrated is mounted on a Leyland Comet short wheel base chassis. This has a glass fibre cab and the driver can turn on his seat to control the crane operation. Travelling dimensions are 17 ft 6 in by 7 ft 6 in wide by 9 ft 6 in high and road speeds can exceed 40 mph.

The crane unit is hydraulically driven, power being taken from the truck engine take-off. There is no king post in the 6 ft 9 in diameter slew ring. Quick setting outriggers steady the load. Hoist speeds with one fall of rope are up to 180 ft per minute and derricking is from 0° to 75° in 20 seconds using a 4-part rope. Slewing is at 2·5 rev. per minute. The standard jib is 24 ft and four additional sections can be carried in the vehicle. Automatic internal expanding brakes on the turntable will hold it in any position. *Brown and Tawse Plant Limited, Ambrose Street, Manchester 2.*

SKIP LOADER

Concrete Distribution



QUICK distribution of concrete by crane is possible with the twin skip loading device now available.

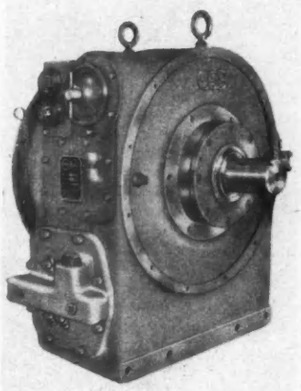
The complete unit consists of two ½ cu. yd capacity conical skips and a suitably inclined tubular stand mounted on a base of channel irons. The stand supports one skip at a height suitable for filling from the mixer and a second skip at an upper position awaiting filling. Each skip is equipped with rollers to allow it to run down the rails into the filling position. A pull rod, that can be fitted either side as desired, operates a release peg through a cranked lever to free the upper skip.

After the lower skip is filled the crane hook is attached and it is transported to the pouring point. The waiting skip is then freed and runs down to the filling position and is filled ready for the return of the crane. The operation means that there is no waiting time for the crane while the skip is being loaded and in addition the skip is better aligned for filling. The same labour force is required as for a single skip and non-production time reduced to a minimum.

Further advantages of the skip are that it is conical in shape so that there will be little or no adhesion of concrete to the sides, and the folding discharge chute allows for pouring into columns at different angles. The discharge chute also has a short arc giving a greater degree of control in pouring. The skips measure 38 in diameter at the top and the discharge orifice is 14½ in by 11¼ in. Filling height is 39 in and the weight 210 lb. The stand measures 120 in long by 47 in wide and weighs 442 lb. *George Cohen 600 Group Limited, Wood Lane, London W12.*

TORQUE CONVERTOR

Transmits up to 350 hp



HYDRAULIC torque convertors models 16 and 17 are suitable for transmitting powers from 38 to 350 hp.

These Clark units work on the Schneider principle and have automatic changeover from convertor to coupling. Maximum torque multiplication is 3 : 1.

The two sizes have wheels 16 in and 17 in diameter and will handle torques up to 580 and 800 lb-ft respectively. The maximum input speed is 2,100 rpm. Working oil pressure is 45 lb per sq. in and temperature 270° F maximum. Oil temperature into the cooler is 225° F; oil capacity is 8 gallons and the oil pump capacity is 16 gpm for each 1,000 rpm of engine.

Three versions of each model are available with open front end (model AK); with closed front end (model BK); or with closed front end and over-centre clutch (model CK). Weights range from 630 lb to 800 lb for the various models.

The coupling effect is obtained by mounting the reaction member on the stationary sleeve by means of a free-wheel unit. This permits rotation of the reaction member during the coupling range but prevents it during the torque convertor range. Whether or not the reaction member rotates depends on the direction in which the oil leaving the turbine strikes the blades. *Self-Changing Gears Limited, Lythalls Lane, Coventry.*

RESIDUAL CHLORINE CONTROLLER

Proportional Action

PROPORTIONAL control of dosage is carried out by an instrument that samples the residual chlorine in treated water.

It can be applied to systems that are being chlorinated or dechlorinated. A continuous sample is drawn off and the content evaluated by the measuring electrodes and the recorder. The indicated residual is then compared with the value required and the controller energized to make the necessary proportional change in the dosage.

When flow variations are large the time interval between the injection and sampling points also varies widely and produces a similar effect on the total process time. The controller can accept a signal from a flow meter operating from an orifice or a venturi to alter the time delay to suit the change in flow. The instrument is available for five ranges covering from 1 to 20 ppm. About 5 gph passes through the measuring chamber. *Wallace and Tiernan Limited, Power Road, London W4.*

America's Ballistic Manned Space Flight

Ironing out the bugs has put the United States almost two years behind schedule. The three man space laboratory, due in orbit in 1965, may be the next advance.

By G. V. E. Thompson, B.Sc.(Eng.), F.B.I.S.

CONSIDERED only as personal feats of courage and endurance, there is little to choose between Major Gagarin orbiting the earth and Commander Shepard shooting up from Cape Canaveral, but there is a considerable difference in the level of technical achievement. Shepard's Mercury capsule reached a maximum velocity less than one-third of that attained by the Russian spaceship Vostok, and in consequence the duration, range and maximum altitude of his flight are much less. Moreover, it should not be forgotten that Vostok could have continued in orbit for several days, had that been thought desirable.

MERCURY PROGRAMME

The origin of the Mercury programme can be traced back to 1947, when R. A. Smith of the British Interplanetary Society drew up detailed proposals for a man to be fired up over 100 miles in a ballistic trajectory into space in a capsule attached to a V2 rocket. This proposal was rejected by the Ministry of Supply. Ten years later, there was a similar suggestion but with the V2 rocket replaced by a Redstone. This came from Wernher von Braun, who had been the brains behind both missiles and was then Director of Development, Army Ballistic Missile Agency, Huntsville, Alabama. Like the earlier one it was shelved, and up to 1958 the US man-in-space programme was based on the X-15 hypersonic research aircraft. The National Aeronautics and Space Administration (NASA) was set up on 29 July, 1958, and together with the Advanced Research Projects Agency (ARPA) of the Pentagon, drew up a specification for an orbital manned satellite capsule to be launched by an Atlas-D ICBM.

The original concept was broadly similar to the present capsule. It was intended to replace the Atlas nose cone with a minimum of modifications and to be in the shape of a truncated cone surmounted by a short cylinder containing a parachute. On top of the cylinder would be a tripod mounting an escape rocket designed to fire aft, so as to lift the whole package free of the booster in case of failure during launching. Retro-rockets would be located on the base of the capsule to reduce re-entry velocity and Atlas nose-cone separation rockets were to be provided to assist escape separation. Attitude (pitch and yaw) and roll jets were to position the capsule for proper reentry.

The initial plan was for a manned orbital flight to be made in 1961, but preceded by several development programmes of sub-systems. Tests at the Naval Air Development Laboratory, Johnsville, Penn., carried out with a giant human centrifuge capable of applying accelerations up to 40*g* soon established that the human support system was suitable; Lt.-Comdr. Carter Collins, USN, used it to withstand 20*g*.

This gave rise to the sub-project and vehicle known as Little Joe (not to be confused with a Second World War ship-to-air missile of the same name), a fin-stabilized aluminium-alloy rocket powered by Thiokol Chemical Corporation solid-propellent rockets. For normal flights these comprise four Pollux and four Recruit rockets, but for short-range flights only two Pollux are used. Little Joe carried a boiler-plate mock-up of the Mercury capsule and tested the escape system. After an initial failure on 21 August, 1959 (when the escape rocket fired prematurely), four successful flights were made in 1959-60, monkey passengers being carried in the last two.

Several aerodynamic researches were carried out on models in various wind tunnels at Langley and the Ames Research Center, California; various-sized scale models were also launched at Wallops Island. The studies were made to determine static and dynamic stabilities; oscillation characteristics; lift, drag, and pitching moments; damping; and permissible centres of gravity. Speeds in the Mach 0·3 to Mach 10 range were covered.

To provide stability during reentry, when the capsule is travelling "blunt end first," a small drogue parachute trails behind it from 70,000 ft down to about 10,000 ft, where the main recovery parachute deploys. The drogue system was taken to high altitudes in USAF Starfighters and dropped over Muroc, California. Telemetry and ciné records gave data on the snatch forces occurring when the parachute package reached the end of the shroud lines, the shock forces experienced when it blossomed, and the reliability of the system.

Comparison of the US and USSR Flights

	USA	USSR
Date	May 5, 1961	April 12, 1961
Duration	15 min	108 min
Maximum altitude	115 miles	187 miles
Ground range	302 miles	Over 25,000 miles
Maximum speed	5,100 mph	About 18,000 mph
Spaceship mass	1 ton	4½ tons

The Schedule early in 1960 provided for a Mercury Atlas shot—designated MA-1—in July of that year, followed by a Mercury Redstone —MR-1—in August. The latter was to carry a dummy astronaut in its capsule. It was to be followed by MA-2 and MA-3 in September and October, 1960, and about that time would come MR-2, carrying a monkey. MA-4 was to carry a monkey in orbit before the end of the year, and the first manned shot (MR-3) was also listed for 1960. However, it was admitted that slippage of the programme was possible, as each shot was dependent upon a complete success of the one before. This schedule was already about one year behind that originally conceived (November, 1959: first Redstone with monkey; January, 1960: Atlas ballastic with instruments; March, 1960: Redstone ballistic with man; May, 1960: Atlas monkey in orbit; June, 1960: Atlas man in orbit).

When the 1960 shots did take place failures occurred, setting the programme back further. MA-1 exploded 65 seconds after launching on July 29, 1960.

In place of the astronaut's couch, and control equipment, the capsule contained over 200 lb of instruments, recorders and a 16 channel telemetry system. This equipment survived the explosion and continued to transmit data until 3½ minutes after launch, when the capsule met the water 5 miles offshore, so the experiment was not a complete failure. However, as a duplicate experiment was not ready at the time, this delayed the programme by 2 months (no one bothered about the need to expend another Atlas, costing £1,300,000, an attitude entirely foreign to Britain, where the Government has been dithering for over a year about whether to allocate £20 million a year for space research).

The MR-1 shot was delayed until November 7, but then had to be cancelled because a valve in the hydrogen peroxide reaction control jet system was found to be not functioning properly 22 minutes before launch. The shot was postponed until 30 November, but this was also a failure, the Redstone rocket shutting down a few seconds after ignition. This was again a relatively cheap failure, as the rocket and capsule remained on the launching pad undamaged.

The MR-1 flight was repeated on 21 December and was an unqualified success; the capsule reached an altitude of 135 miles and travelled 235 miles downrange. It was recovered showing only minor damage: some scorched paint and a broken port glass (not of serious consequence, as four thicknesses were provided).

Mr. Ham, a 37 lb chimpanzee, flew in MR-2, launched 31 January, 1961. The flight plan called for a range of 290 miles, but the Redstone engine thrust regulator failed to hold the thrust below the specified limit. Propellent was consumed too rapidly and the LOX ran out about five seconds earlier than programmed and about two seconds earlier than the abort sensing system. Escape rockets were automatically fired.

To reduce capsule weight to a minimum and thus ensure adequate ejection of the capsule in the event of a booster explosion, the retro-rocket system is left behind when the escape package fires. In the case of MR-2, additional speed was added to the capsule; about 480 mph from the additional Redstone thrust, about 350 mph from the action of the escape rockets. It therefore rose to 155 miles instead of 115 and had an apogee velocity of about 5,500 mph instead of 4,400. The absence of retro-rockets eliminated the possibility of slowing the capsule by about 350 mph at apogee. The final result was that reentry was severer than expected and the range was 420 miles instead of 290.

ORBIT OBJECTIVE

Fortunately, search planes were able to locate the capsule and it was found that Mr. Ham was in excellent condition despite the greater reentry stress.

MA-2 test flight took place on 21 February this year, and was a ballistic shot with a range of 1,424 miles—from Cape Canaveral to 410 miles ENE of Puerto Rico. It reached an altitude of 107 miles and a maximum velocity of 12,850 miles. The capsule was unscathed, although the reentry was programmed to be more severe than intended for the manned flights. Deceleration at 16½*g* was more than twice normal, reentry heating was 30 per cent up, temperatures 25 per cent higher and the air loading (900 lb per sq. ft) three times normal.

A landing bag test was made in Little Joe 6 flight on 18 March. The bag behaved properly, but it was not a full test as the parachutes opened early and slowed descent much more than normal. The capsule was fitted up again and retested on 28 April. This time trouble was experienced with the booster, one of the six solid rockets igniting some 3 to 4 seconds after the others, so that the vehicle took off at a lower angle than intended and only reached a height of 14,000 ft (instead of 35,000 to 40,000 ft). However, the behaviour of the capsule was otherwise satisfactory, and by this date Gagarin's flight had taken place. It was therefore decided to go ahead with Shepard's flight in MR-3.

It is expected that this will be followed during the summer by similar flights made by the other two astronauts (John Glenn and Virgil Grissom) who represent the "short list" from seven trained for this purpose.

The next step forward for America is the manned orbital flight, which is not likely to take place before 1962, nearly two years behind the original schedule. At the moment, the prospects are not good, because the reliability of the more powerful Atlas missile has not proved comparable with that of Redstone.

America has two other manned space projects which are likely to be hastened as a result of events during the past month. They are Dynasoar (a boost-glide vehicle which can be regarded as a more advanced X-15) and Apollo a three-man laboratory, due in orbit by 1965.

Hardness Check for Engine Running Temperatures

A simple technique for measuring the operating temperatures of engine parts like valves and pistons has been developed by scientists of Shell Research Limited, at their Thornton, Cheshire, Research Centre. Known as the "hardness relaxation" method, it depends on the change in hardness undergone by certain alloys when they are heated and cooled.

The usual temperature measuring devices cannot easily be attached to these rapidly-moving parts inside the engine block, but Thornton has developed a technique whereby each component literally registers the maximum temperature to which it is exposed. When the engine is taken apart, this temperature is deciphered in the laboratory.

High temperatures can build up locally on pistons, rings, bearings, gears and valves, and if they become too high pressure failure can result. As a result of this new technique engineers can now pin point these hot spots and then take steps to overcome them.

Thornton's "hardness relaxation" technique, depends on the fact that when certain alloys are heated and then cooled, their original hardness is changed. The extent of the change depends on the maximum temperature reached. This fact in itself is not new, but Thornton has applied it in measuring the temperature of moving parts in cars and also in a variety of large engines, with notable success.

Usually it is only necessary to compare the original hardness of an engine component with its hardness after running to determine with accuracy the maximum temperature reached in the range of 100° C to 1,000° C (212° F to 1,832° F). When the metal of a particular engine component is not suitable for recording accurately the maximum temperature reached, small inserts of a suitable alloy can be fitted in the part under study. The change in hardness of the insert will then give a measure of the maximum temperature reached. Thornton has developed a wide range of alloy inserts for this purpose.

An interesting application of this technique helped solve the problem of a car owner in the Australian bush. The car was a make renowned for its performance and no one could diagnose why it would go for a few miles and stop. Thornton was advised of the symptoms and the engineers there were fairly sure the spark plugs were overheating. To check their hypothesis, they sent out a set of specially-prepared plugs. These were run in the car and then sent back to the laboratory 12,000 miles away. Examination of the change in hardness of the plugs showed that temperatures in the region of 1,000° C were being reached. It was a simple matter to adjust the timing to make the engine run cooler.

By introducing alloy inserts into engine components and measuring their hardness before and after running local operating temperatures can be determined.

More Comfort and Performance for Aston Martin DB4

The performance, safety and comfort of the Aston Martin DB4 have been further enhanced by a number of changes—points of detail that have resulted from the continued development of the model.

The DB4 is now offered with the Laycock de Normanville overdrive as optional equipment, which permits the use of a lower final drive ratio and provides even greater flexibility with high cruising and maximum speeds. A 4·09 : 1 final drive ratio can be used for flexibility and optimum acceleration, with 120 mph cruising in overdrive at only 4,700 rpm, and a maximum speed of 147 mph at 5,750 r.p.m.

The other new features are as follows. The output of the heater has been greatly increased and the demisting system redesigned. A new development in windscreen wiper arms and blades ensures that the windscreen is effectively cleared of rain even at 120 mph. A new and more convenient switch embraces the functions of headlamp flasher—essential on a fast car—dipper and turn signals. New silencers have been developed to reduce still further the noise level without loss of performance. There is also additional sound insulation. Finally, the body panels are produced from 2 per cent aluminium magnesium and 1·26 per cent aluminium manganese alloys, combining ultra-light-weight with maximum stiffness and strength.

Gas Turbines, Air Braking and Dreams

A gas-turbine engined car, made by the Chrysler Corporation and known as the "Turboflite," was shown recently to members of the American Society of Mechanical Engineers in Washington. The car is illustrated in Fig. 1. The gas-turbine is of regenerative pattern and weighs only half as much as the conventional Chrysler V-8 power unit. As can be seen from Fig. 2, the turbine fits neatly inside the engine compartment of a normal Plymouth car.

A feature of the Turboflite, designed to compensate for the absence of engine-braking with a gas turbine, is an air-brake system. Suspended between two struts at the rear of the car is a horizontal flap, as shown in Fig. 1. The flap pivots up into the airstream when the brakes are applied, creating drag and helping to slow down the car. It also serves to prevent excessive acceleration. The Turboflite also embodies a canopy which rises as a unit when the door is opened.

Among the major problems in designing a small gas turbine, suitable for use in a car, is the question of thermal efficiency. A normal heat exchanger capable of making such a turbine economic is very bulky, and could certainly not be fitted in a car. A regenerative system, in which heat is transferred by means of a rotating heat absorber or some similar mechanical means, may be the answer, but the design of a practical regenerator also presents technical difficulties. The Chrysler regenerative gas turbine represents a further stage in this development, but there are at present no plans for large-scale production of the engine for use in passenger cars.

At the International Motor Show in Geneva, which closed this week, a number of new or unusual cars were shown for the first time. Probably the most successful was the E-type Grand Touring Jaguar, described in Automobile Review on 17 March. Another departure, but perhaps less ready for the market, was the "Selene II" by Ghia of Turin, illustrated in Fig. 3. It was one of the Italian "dream cars" shown at the exhibition.

Fig. 1 A regenerative gas-turbine powers the Chrysler Turboflite, which has air-braking and a canopy which rises when the door is opened.

Fig. 2 The Chrysler gas turbine also fits into the engine compartment of a normal Plymouth car and weighs half as much as conventional V-8 unit.

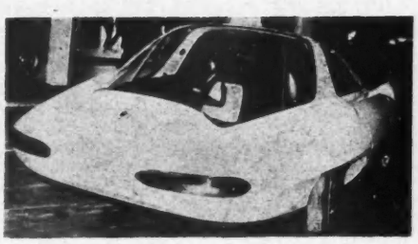


Fig. 3 The Selene II, an Italian "dream car" designed by Ghia of Turin and exhibited at the recent International Motor Show, Geneva.

Tormenting Trials

RECENT criticism that the Dounreay Fast Reactor had fallen on bad times and foreign rumours that it was to be abandoned have been refuted in a statement by Sir Roger Makins and a further release by the Authority itself. The problems associated with gas entrainment appear with the present knowledge to be understood, after the experience gained with the initial low power runs on the DFR. But it will be necessary to test the modifications and to examine their effects before the problem is finally conquered.

Beryllium cladding for the first core loading of the Advanced Gas Cooled Reactor at Windscale has proved too hard an obstacle to overcome, and the Authority have succumbed to using stainless steel for the majority of the first loading.

Although a retrograde step, it is intended that further research with beryllium will permit a larger percentage in the second core.

Gas Entrainment Effect

The problem of gas entrainment has been appreciated by the Authority during the design and construction of the Dounreay Fast Reactor and it was not until the reactor became a working project that a true estimation of the problem could be made. The problem arises due to very high heat ratings coming from a small core. Since liquid metal coolants are the only medium suitable for removing the heat produced, in the case of the DFR an alloy of sodium and potassium is used. This alloy oxidizes extremely easily and catches fire if exposed to the air. Thus the spaces above the coolant in the reactor must be filled with an inert gas, and nitrogen is used for this purpose.

Problems Encountered

During the first physics experiments in the DFR programme small changes in the reactivity were noticed, which were found to be due to bubbles of nitrogen entrained in the sodium-potassium coolant passing through the core. This was serious not only because of the changes in reactivity but also under power conditions the coolant heat transfer properties would be effected leading to local hot-spots which might bring about melting of the fuel.

Preliminary tests showed that a reduction of the level in the liquid metal expansion tanks was allowing gas to pass down a pipe which was normally filled with liquid metal. To combat this further instrumentation was added in order to help locate the trouble spots during the shut-down last year to change the core. Further tests showed that two other mechanisms were taking place, encouraging gas entrainment: the pressure drop occurring at certain coolant flow rates in the vertical tubes which form part of the control rod mechanism caused nitrogen to be drawn down the tubes into the main circuit; and a similar effect occuring in the instrument thermocouple tubes which lead down into the core.

Action Taken

The tank emptying effect was found to be due to the blocking of small pipes and these are being cleared. Modifications are being made to control rod and thermocouple tubes to alter their hydraulic characteristics by providing relief holes and baffles. At the conclusion of this work the programme for raising the reactor to power will be reviewed. The highest power reached so far is 1·4 MW. The chemical processing of the first charge has been successfully carried out proving the operating characteristics of the processing plant.

Windscale Review

It is intended that the construction of the Advanced Gas Cooled reactor at Windscale will be completed in July and that the reactor will be handed over to operation staff for fuel loading in the late autumn. Inside the reactor vessel the graphite core and its supports are complete and the neutron shield has been erected. The burst cartridge detection pipes are being fitted and connected to the precipitators which have already been installed. Modifications were necessary after testing one gas circulator at design temperature and pressure, but the second machine has been delivered and continuous running tests are proceding. Outside the reactor containment building, construction is practically complete. The majority of the electrical plant in the turbine hall is installed, the dump condensor is finished and erection of the turbine is well advanced. Labour troubles have also retarded HERO, the zero energy facility at Windscale, and the handover is now expected to be in the autumn.

Fuel and Canning

Progress is being made in the production of uranium oxide pellets for the fuel elements; quantity production of components for the stainless steel canned elements has begun and the assembly plant is being commissioned. In spite of the difficulties experienced with beryllium production, and the corrosion problems which have arisen, a quantity of beryllium-canned fuel elements are being produced and it is planned that up to 20 per cent of the first charge will be beryllium canned.

Examining the reflector of the S2DS lightweight reactor part of the SNAP programme.

SNAP Programme Progresses

The reactor illustrated above went critical on April 3, 1961. It is a prototype lightweight reactor for the production of auxiliary power for space vehicles. The reactor weighs 200 lb without a shielding and is 13 in high and 9 in diameter, the fuel is uranium-zirconium hydride alloy and generates 50 kW of heat. In an operational device the heat from the core will be removed by liquid sodium-potassium coolant to a boiler containing mercury. The mercury vapour will then be directed into a miniature turbine to generate 3 kW(e). The reactor designated SNAP 2 Development System(S2DS) Reactor, will be mated to its power conversion unit for ground testing of the complete SNAP 2 system later this spring. The S2DS was designed, constructed and operated by Atomics International, a division of North American Aviation, Inc.

Spectral Shift Control

In June 1960 the United States Atomic Energy Commission awarded a contract to Babcock and Wilcox Company to study the basic physics of the Spectral Shift Control Reactor (SSCR) (Atomic Review, 16 Sept. '60). By varying the concentrations of light and heavy water as a moderator, it is possible to compensate for reactivity changes by taking advantage of the alteration in the spectral shift in the neutron energies. These changes occur as the reactor fuel is consumed and the poisons are built up. Initially in a Spectral Shift Control Reactor higher concentrations of heavy water would be used in order to hold down the number of fissions caused by thermal neutrons. However, it would also allow epithermal neutrons to cause fissions or be absorbed in fertile material. Thus as the fuel is consumed and poisons built up the reactivity loss would be compensated by increasing the proportion of light water. This would allow more fissions by thermal neutrons, increasing the reactivity correspondingly. Major advantages sought in the SSCR concept include longer fuel lifetime and consequent lower fuel costs, more uniform power distribution, improved neutron economy, greater production of fissionable material, and minimum control rod requirements.

Future of the SL-1 at Stake

The *ad hoc* advisory committee, appointed to consider the future use or deposition on the SL-1 reactor at Idaho Falls, reconvened to review information that has become available since the initial report on January 12 and to consider recommendations for decontaminating and dismantling the reactor. It is now understood that there is little or no water in the reactor vessel after placing two probes into the vessel last month. The absence of water is contrary to an earlier assumption based on studies of motion pictures of the inside of the reactor vessel. Present radiation levels in the reactor room range from 30 to 200 roentgens per hour; immediately after the accident the levels ranged from 500 to 1,000 roentgens per hour, the higher readings being taken over the top of the reactor vessel.

Reactor Notes

ML-1 Goes Critical: The ML-1 was the twenty-ninth reactor to go critical since the establishment of the National Reactor Testing Station at Idaho eleven years ago. The ML-1 went critical for the first time on 30 March and after several months of low power testing and evaluation, the reactor will be coupled to the gas turbine and generating equipment capable of producing 300 to 500 kW(e).

Dual Purpose Reactor: Under the $30·1 million overall increase in the United States Atomic Energy Commission's budget, President Kennedy has proposed that the plutonium production reactor at Hanford, due for completion next year, after producing plutonium for two years should be converted to produce electrical power of 760 MW(e).

India's Second Plant: The second nuclear power station is probably going to be located in the general area of Rajasthan—East Punjab—Uttar Pradesh and Delhi. The preparations for the plant will begin in the third plan period and completed in the fourth. It is also reported that the contract for the Tarapur plant should be awarded by the end of this year.

Another Reactor Critical: The Los Alamos molten plutonium reactor experiment No. 1 (LAMPRE-1) achieved criticality on April 3. The reactor uses a molten alloy of plutonium and iron as the fissionable fuel which may be used later in fast breeder reactors. It has a maximum rating of 1 MW and operates at approximately 950° F using sodium for the coolant.

Companies

Shipbuilders Seeking Rating Amendments

Those shipbuilding firms which have spent heavily on modernization in order to meet the fierce overseas competition now find themselves likely to be the worst hit by the revaluation of their establishments and by the proposed abolition of industrial derating.

Urgent representations have been made to the Government by the shipbuilders for special provisions for the industry in the Rating and Valuation Bill, which last week reached the Report Stage in the Commons. As it stands the Bill gives the Government no power to deal with such special cases as shipbuilding and there is growing evidence that without such assistance the added cost burdens will seriously weaken the competitive position of the yards.

The position in Scotland, where if additional unemployment is allowed to spread out from the shipyards it will be added to a level already substantially above that found further South, is that even before the loss of derating, tens of thousands of pounds have been added to the costs of individual yards. The effect is to put thousands of pounds on the tenders submitted for the limited amount of business available. When the 50 per cent derating is abolished in 1953 the position will be that much worse, if nothing is done by way of remedy.

One Clydeside example, given by the Shipbuilding Conference, is of a company that has spent millions on modernization. Its current annual rate bill is £9,000, in 1963, with revaluation and the end of derating this will have become £100,000. At a time of low order books, and an output of two or three ships a year, the effect on the price, and so on future work for the yard, could plainly be disastrous.

The Conference puts it like this: "It is certainly the antithesis of incentive so to penalize firms in this way who have accepted the challenge of the severest competition known for 30 years, and who in official and unofficial quarters have been roundly criticized for not having spent enough of their resources on modernization."

Proposed Cure

As an assembling industry, shipbuilding cannot escape the cumulative effect of revaluation and derating on the costs of its suppliers all the way along the line. Its own necessarily large and costly facilities put it in the same category as iron and steel for vulnerability to heavy rateable assessment.

Despite the Government exhorations on the need to do better with exports the shipbuilders representations have so far met with no response. A chance for the authorities to act is contained in the amendments now tabled to the Rating and Valuation Bill which are designed to exempt shipbuilding from the abolition of derating or to give the Minister of Housing and Local Government power to make special provision for assessing the rateable value of shipbuilding facilities.

An alternative amendment seeks to give the Minister power to determine rateable values in any depressed industry.

The contradiction in official attitudes is an obvious one. Generalized calls to action in the export markets continue to flow freely. Whatever the voice is saying the action taken is that the shipyards, whose business is by its nature world wide, are burdened with great financial disadvantages, burdens which for a final irony, are in direct proportion to the capital invested in doing the best possible job.

Shipping Tenders Without Profits

In an effort to attract orders to keep the labour force together and the yards working, the South Shields shipbuilders, John Readhead and Sons, have been dropping the profit margins from their tenders.

Continuity of employment was declared to be vital by the company's chairman and managing director, Mr. Harold Towers, after the recent launching of the 12,800 ton cargo liner Gorjistan for the Strick Line, of London. Mr. Towers described the company's desperate, and with the exception of one ship, so far unsuccessful search for new construction for delivery next year and in 1963. The company has work in hand at the moment until March of next year. The keel of the last ship on order will shortly be laid in the berth vacated by the launching of the Gorjistan.

Some of the increasing demands being made on the industry as it fought for survival were the graduated pensions scheme and the Budget's increase in profits tax. As with the Shipbuilding Conference, Mr. Towers sees the abolition of derating looming ahead, and also the possibility of the newly proposed payroll tax.

Dunlop Rubber To Use Leo Computer

An advanced LEO III automatic office is to be installed at the Dunlop Rubber Company's Fort Dunlop, Birmingham, next year. Fully transistorised, the LEO III is the fastest LEO computer yet built. Its results are produced on printers working at 880 lines a minute.

The automatic office at Fort Dunlop will first be used to produce invoices and accounts for the immense tyre replacement business. In this sector alone there are 5,000 daily orders over a range including 30,000 items. The next phase will be to bring control of the supplies to vehicle makers on to the computer as well as all the sales statistics.

Subsequent work for the LEO III will include:

- Stock control of finished products in 50 depots and base stores and of 28,000 stores items from 2,000 separate suppliers.
- Calculating the pay for 9,000 Fort Dunlop employees.
- Calculating sales and production requirements for buying and factory loading purposes.
- Sales forecasting for all markets.

The first set of programmes will be prepared and run on a pilot basis at the LEO III service bureau in Bayswater, London, before the computer is delivered to Dunlop.

Able to tackle several jobs simultaneously, the computer is not held up by having to wait for ancillary equipment to catch up with it because of a number of time sharing arrangements.

Reliability in high speed computers has been brought to the pitch where LEO III has had to have carefully planned breakdown exercises worked out in order to give the maintenance engineers practice.

Anglo-American Blast Furnace Deal

An exclusive agreement for the manufacture, sale and installation of Mohr designed blast furaces and ancillary equipment in the United Kingdom and in the Commonwealth has been reached between Newton Chambers and Company, the Thorncliffe, Sheffield, engineers, and John Mohr and Sons, of Chicago, Illinois, USA.

Newton Chambers, who until recently operated their own blast furnaces, have built blast furnaces and a wide variety of ancillary equipment for steelworks. The company's ironworks were first established in 1793.

John Mohr and Sons have been engaged in these fields of engineering since 1857 and have a leading reputation

in the United States as designers and constructors of blast furnaces and steelworks.

Some of the most advanced developments in blast furnace design, particularly those related to high top pressure, have come from the United States, with Mohr designers well in the forefront. The first blast furnace in the world working in high top pressure was installed by John Mohr in 1942 at the Cleveland Works of the Republic Steel Corporation of America. The company has since that date installed, or has under construction, some 20 blast furnaces at United States steelworks. The blast furnace illustrated was installed by Mohr for Dominion Foundries and Steel, USA.

For the Duquesne Works, in Pennsylvania, of the United States Steel Corporation, John Mohr have an order for a furnace with a hearth diameter of 28 ft working at 30 lb per sq. in top pressure, which will be fully equipped including a completely automatic stock-house. Its capacity will be up to 4,000 tons of pig iron a day.

The Newton Chambers-John Mohr agreement makes available to the British company the latest designs of the American concern for the full range of blast furnaces and also for: gas cleaning plant, hot blast stoves, valves and their automatic control, programme control up to the level of the completely automatic stock-house and an established system of control for high top pressure.

Skefko in India And Scotland

The widespread effects of the recession in the car manufacturing firms and in some consumer goods companies are still the subject of occasional comment, one of the most recent being that from the Skefko Ball Bearing Company, of Luton.

The results of the credit restrictions, and the heavy fall in demand from the car industry caused Skefko considerable "rearrangement" in their production plans. Although Sir Victor Mallett, the Skefko chairman, has to report falls in the order book in these later months of last year, and in the early months of this year, he is able in the annual review to report that the recession made less impact on the order books than might have been expected.

Prospects now are that the demand from passenger cars and consumer goods have shown some improvement although the company cautiously feels that their levels of activity may not, in all instances, reach the peaks of 1960. Taken all round, 1961 is not expected by Sir Victor to yield results less satisfactory than those of last year.

Following the suggestion of the Board of Trade, Skefko is pursuing its expantion programme over the border to Irvine, Ayrshire. A great deal of assistance has been received from the Board's officers, county and local government officials and many others. Production is now expected to be started before the end of the year.

Participating in a new bearing factory in India the company are in partnership with their parent concern—SKF Gothenburg—and with the Investment Corporation of India, a member of the TATA Group. The new Indian company is to be called Associated Bearing Company.

At home two wage increases since the beginning of last year and the effects of the shorter working week have been putting further pressure on production costs. New machines and improved manufacturing methods have been used in the efforts to keep down costs.

New Steam Condenser Design for CEGB

The Central Electricity Generating Board are to place a £1·5 million contract with Associated Electrical Industries for steam condensers to be used at a new 2,000 MW power station to be sited, it is undersood, in the Midlands.

The four condensers will be the largest ever made and will be of completely new design. To be manufactured at the AEI heat exchange works, Petershill, Glasgow, the condensers are to be used in conjunction with four 500 MW single axis steam turbines.

Tapes Prevent Scratching of Sheet Work

Wide self-adhesive paper tape will protect polished sheet and can withstand forming. Here are comments of five firms.

IN THE autumn of 1959, Gordon and Gotch (Sellotape) became associated with Mystic Adhesive Products of Chicago. One of the ideas which has sprung from this—and there have been plenty in both directions, say Gordon and Gotch—is that of launching a self-adhesive paper tape in the United Kingdom. This would be used for protecting sheet metal during forming operations. There was a reason for thinking that this would be successful—for the American company's sales of a similar product account for a substantial part of its annual turnover.

The aim of this article is to present comments of several users of this newly launched British product, and the experiences of the firms are reported verbatim under their names.

For protecting polished metal during forming there are many paper or plastic films which could be used. You will read here, for instance, that two firms used newsprint and brown paper for this. What Gordon and Gotch have chosen to name Paper Protection Mask, therefore, is really a development of a straightforward idea.

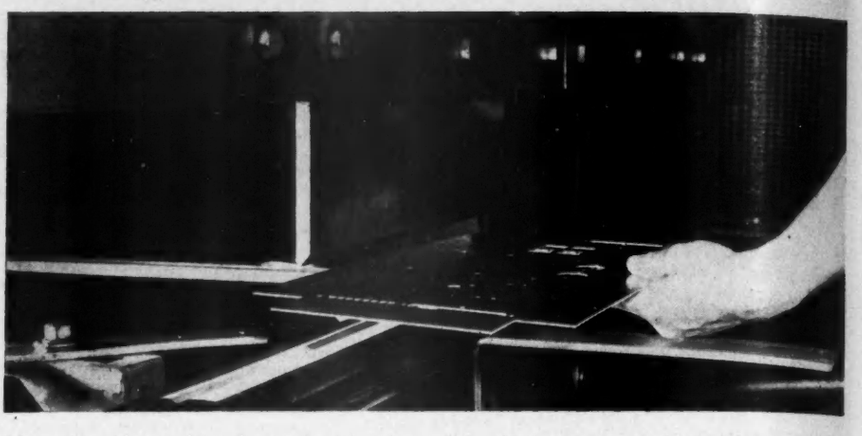
This tape product is supplied in widths up to 48 in and there is an applicator which in its present form rolls it on to flat surfaces. Without this it is quite difficult to handle such wide tape, say Gordon and Gotch. The paper tape is based on lightly impregnated flatback paper with a semi-cured latex coating on it. Thickness is 0·005 in, tensile strength is 17 lb per in width, and the adhesion to metal is 7 ounces per inch width.

When metal is formed with this paper tape applied to it, the paper will tear after 6 per cent elongation. This is small compared, say, with the elongation of 25 per cent given by a pvc-based protection tape also sold by Gordon and Gotch, yet the paper gives unusually good protection; when the paper tears, the rubber latex retains its continuity by stripping from the back of the paper so as to retain a rubber film between die and metal surface. The stretching of the latex cures the rubber, and the film itself goes on extending for about 100 per cent.

An interesting aspect of using a self-adhesive mask is that marking out for bending and cutting can be done on the paper without leaving any surface scratches.

You will note comments about the high cost of this protection tape. Yet this is tempered in all three cases by the additional comment that the cost of polishing out scratches is also expensive; and that is what the protection is designed to avoid. At the time of going to press, Gordon and Gotch quote a basic price of 6*s* 3*d* per sq. yd for orders of less than 100 sq. yd, 5*s* for 100 or more, reducing to 3*s* per sq. yd for 100,000 sq. yd.

Gordon and Gotch (Sellotape) Limited, 8-10 Paul Street, London EC2.



Marconi avoid scratch marks on aluminium by applying this paper tape to the V die of their brake press. On the right (below) are three items which have been formed on a protected die and three on one without protection. Note the elimination of forming scratches. (See the company's comments opposite).

T. Giusti and Son Ltd.,

210-212 York Way,
Kings Cross, London N7.

We produce tailor-made equipment for the chemical industry. We have no repetition work, so we want a general protection during the handling of the steel sheets. We utilize mainly stainless steel, and this reaches us with a polished surface—sometimes very highly polished. This surface tends to be damaged in transit and while moving the sheets into stores, and of course during the operation of fabrication.

What we are aiming to do is to obtain from the mills sheets covered with this protective paper.

With reasonable handling the paper backed with latex sticky coating, which we have tested, appears quite successful. Sharp edges could still dig through, but in general the sheets can be bent and rolled—with the paper affording reasonable protection.

Up till now no protection has been used, though bending rollers have been covered with paper and great care taken in the handling of the sheets. We have found that, during fabrication, scratches and marks occur on the polished stainless steel and the only way to remove them is to repolish the whole job when completed. If the sheets can be protected by some covering which can be peeled off, the only grinding and polishing necessary is along the weld lines where sheets are joined, and considerable work can be avoided.

This paper protection is rather expensive, but the cost of repolishing the whole article is greater than the cost of the protective paper.

In future development of these materials, we would welcome a protective covering to the stainless steel sheets direct from suppliers at half the present cost and with a shiny, hard surface that will avoid grit and swarf sticking into it.

Samuel Fox and Co. Ltd.,

Stocksbridge Works,
Near Sheffield.

We are suppliers of stainless steel sheets, hence our only interest in this is a service to our customers. We have been keeping in touch with developments in the field of sheet protection for several years, paper tape protection being one of a number of methods we are watching.

Our tests show it to be effective in preventing scratching in handling and basic machining operations. Compared with some of the older tapes, the paper one we now have under consideration is relatively easy to apply.

Hobart Manufacturing Co. Ltd.,

New Southgate, London N11.

The tape is used to cover polished stainless steel sheets prior to all fabrication operations such as shearing, piercing, drilling and forming. It offers satisfactory protection from scratches and abrasions during normal fabrication handling. It does not protect the material from weld burn. The paper is found to be easy to put on and to remove.

Previous protection was by application of newsprint using an industrial (wall-paper) type paste. The application of this paper was a lengthy procedure and the removal of the same was costly.

As our products consist of rather large components it is important that the stainless steel sheet does not become deeply scratched during fabrication, and it has been found that although

Conclusion on following page

Silicone Fluids Discussed in London

ICI recently arranged a meeting of representatives from Ministries, airlines, and aircraft and associated manufacturers. The aim was to encourage discussion of two improved silicone hydraulic fluids called Silcodyne H and M. These are better known under their General Electric number of RB47.

This is not the first time that these industries have been faced with promotion of silicone fluids—discussion has been going on for years—and it was noticeable that few questions were asked other than those which were admirably answered in literature prepared by ICI for the occasion. This up-to-date literature is available.

Silcodyne H is the basic material. In the words of ICI, "this has good lubricity and low flammability, together with the desirable properties of conventional silicone fluids, namely: low rate of change of viscosity with temperature, high thermal stability, stability to hydrolysis, and resistance to shear breakdown." It appears that in development work, General Electric in the USA and by ICI Nobel Division in the UK, both found that there was no additive which did not either freeze out at low temperatures or boil off at high ones. Thus, Silcodyne H contains none. Silcodyne M is a similar basic fluid but with a small amount of additive to prevent oxidation at high temperatures.

The Silcodynes are made in America by General Electric and ICI do not plan to make them in this country for some time. In reply to a suggested rumour that a 40 gallon drum would cost about £1000, ICI replied that the cost of silicone fluids would always be at least two to three times the cost of phosphate ester fluids. This is a big drawback. But, of course, the long term cost of using fluids depends not only on the first cost of filling a system, but on the replacement rate due to degradation and also to losses through seals. From both these aspects the silicones are very good. Mr. Brown, of the Silicones Department of General Electric, who addressed the meeting in London, said that it was only recently that any shear breakdown has been measured; and it was found that the liquids recovered their viscosity after removal of the shearing forces. In thermal resistance they are particularly good: Silcodyne H is stable to about 316° C and the decomposition rises to only 2 per cent per hour at 370° C. Oxidation resistance should not be critical as most hydraulic fluids operate in a closed system, but for Silcodyne H this commences at 220° C and for Silcodyne M with its additive this is increased to 266° C.

These silicones have low bulk modulus—about 150,000 lb per sq. in at room temperature compared with twice this figure for accepted fluids. This means that hydraulic systems must be built with large reservoirs, should best be prepressurized, and must generally cater for low bulk modulus. These figures vary with pressure and bulk modulus is about doubled on increase of pressure from 0 to 5,000 lb per sq. in at 250° C.

Mr. Brown reported that unexpected behaviour had been found in foaming to which silicones are prone in hydraulic systems. This was minimized, it appeared, by arranging for the liquid to be under constant shear and swirl.

One of the generally accepted shortcomings of silicones is their bad lubricity—which means their power to adhere to metal surfaces and act as lubricants. Adhesion, said Mr. Brown, is very low. However, reasonable lubrication had been arranged in particular instances by, for instance, arranging for the liquid to be sprayed in front of balls in a race, and by opening up clearances particularly in retainers.

The silicones raise several difficult compatibility problems, both with regard to container and seal materials and also other hydraulic fluids. For instance, it was noted that the diester fluid DTD585 formed a gell with Silcodyne and that even if this fluid was not present in a hydraulic circuit it was still common practice to test components with DTD585 before final assembly. One user had found that such parts had to be cleaned first with white spirit, then with a mixture of DP47 (Silcodyne) and one of the few miscible mineral oils such as 1010, and lastly with DP47 itself. It even seems that the fluid is going to present difficulty with silicone greases such as DP49 because this contains DP47 which would be leached out to leave a nasty residue.

Choice of rubbers for use as dynamic seals is not particularly easy and will require quite different solutions from those found for the Skydrols. Mr. Brown said that Viton A and B are good at high temperatures but are not good down the low end of the scale. Teflon was compatible, but suffered from cold flow and creep which made the design of seals difficult. Poly FBA will stand up to temperatures approaching 200° C. Dowty Seals reported that they had developed a rubber compound which was good over the range −40° C to 90° C, but that they had found no one compound for the whole working range of the fluids. They had also found that a big drawback of nitrile rubber—which appears a probable rubber because it only undergoes leaching of the plasticizer—was its high shrinkage at 70° C in the fluid of about 5 per cent.

It appears that carbon seals will cause no problem in hydraulic systems provided that there is a continuous flow of fluid over the face of the seal. This flow need only be very small, say two drops per hour. Very coarse carbons should be avoided, yet phenolic resin-filled and metal-filled carbon seals have been used successfully.

One firm inquired whether use of Silcodynes would mean more extensive filtering arrangements during charging an aircraft. ICI commented that Silcodynes are prefiltered through a 2 micron (guaranteed 5 micron) ceramic filter which also removes moisture. But it was not easy to keep control of particles flaking off the inside of delivery drums or entering from the outside of these. Certainly, it was to be expected that anything such as dirt particles would upset the lubrication of parts by the silicones as their adhesion to metals was already so low.

Silcodyne H is being promoted by ICI as a hydraulic fluid only—and one firm reported at this meeting that it had already been specified for one British aircraft (though unknown to ICI at the time). Silcodyne M is being promoted as a hydraulic fluid and also as an engine oil especially for jet engines. It is here that its resistance to oxidation and the way it will be used with carbon seals will have to be given careful consideration.

Imperial Chemical Industries Limited, Millbank, London SW1.

Concluding

Tapes Prevent Scratching

the paper is expensive the saving on polishing operations is sufficient to offset this.

We would welcome any development that would make it easier to strip off a portion of the paper from the middle of a surface in order to expose an area for welding.

An Aircraft Company

The protection tape is not yet in general use in our factories but is to be used for protection of light alloy aircraft components during folding, drop hammer pressing and brake pressing operations. It is easy to apply and remove. It is effective against scoring by drop hammer punches and dies and against tool marks left after folding. It is resistant to bruise marks left by local panel beating with a mallet. We do not use it on deep drawing operations. However, during press work it has been noted that after the paper backing has broken, the rubber remains intact up to 75 per cent elongation.

In our operations it will replace layers of cloth tape on brake press folding tools and will obviate the need for burnishing and polishing out drawing marks from components requiring a high standard of finish. As yet we are unable to quote relative costs. The material is expensive, but so is the cost of labour to remove the offending drawn marks.

In future development of this tape we would welcome about 100 per cent more wet grab (or tackiness).

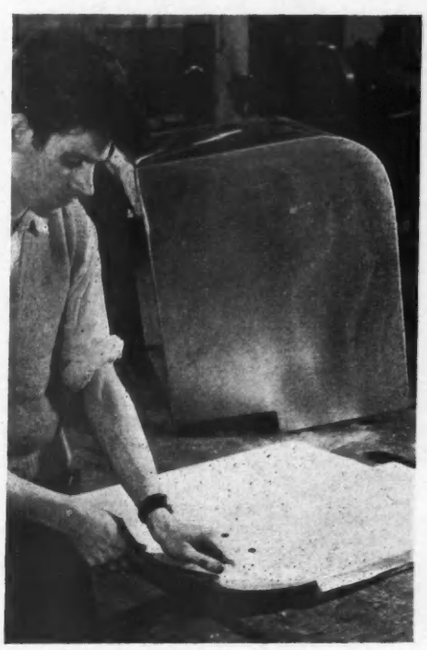
Marconi's Wireless Telegraph Co. Ltd.,

Marconi House, Chelmsford.

Paper tape is used by us to avoid drawing marks on aluminium alloys during the brake press bending operation. We have found it effective in prevention of marking by the dies in this operation. Previously we attempted to get the same result with smooth brown paper.

To quote costs would be extremely difficult as we do not apply the tape to the job. The tape is applied to the V die on the machine (see illustration on the opposite page) and its life depends on the thickness of the material to be bent plus the tightness of the required inside radius of the bend.

We would welcome a thicker, stronger paper backing.



Hobart Manufacturing apply tape before forming, notching and nibbling. It is removed locally to allow welding, but is afterwards replaced until sheet is finally polished. The company's comments appear on this and the previous page.

Controlling Quality on a National Basis

In the face of international competition, the Swiss watch industry has decided to enhance its reputation and product quality by devising a system of national inspection.

THE Swiss watch industry is now preparing itself to meet fast growing competition from abroad. Though the Swiss watch continues to dominate world markets, other countries are improving their products significantly and, appreciating this situation, leaders in the Swiss industry have reached the conclusion that their future depends more than ever on the quality and superiority of their own products. In order to achieve this they have taken what must seem to a non-Swiss to be rather unusual steps.

Watch tests, or rate observations, have been carried out in Switzerland since the first tests were instituted in Geneva in the 18th century. Now, after an intensive survey of the situation and a series of practical experiments, the industry has submitted to the Federal Authorities a proposal that they should introduce legislation for the testing and control of watch quality on a national basis. It is difficult, perhaps, for us to imagine an industry asking its government to impose legislation on it, but that is virtually what the Swiss watch industry has done in its determination to demonstrate to world markets that their's is a quality product.

A committee set up by the Federation Suisse des Associations de Gabricants d'Horlogerie (FH) —the Swiss Federation of Watch Manufacturers —started investigations in the autumn of 1958, in cooperation with other organisations within the industry. This committee consisted of manufacturers, technicians and scientists. After a study of the standards adopted in other watch manufacturing countries, a series of tests was undertaken on 60,000 watches from May to July, 1959.

Basing their calculations on these experiments the FH were able to establish a minimum quality control standard, and on 25 April, 1960, an "FH Watch Control" organisation was set up on an optional basis. There are now ten control centres, set up in areas where watch manufacture tends to be concentrated, with their work coordinated from the Neuchatel observatory.

CONTROL STANDARDS

The FH control standards have been devised to meet the following requirements.

(1) Speed of measurement;
(2) Simplicity of operation, enabling manufacturers to simulate the testing procedure themselves without expensive new equipment;
(3) Effective control, guaranteeing good performance from the watch;

An examiner scrutinizing watches under test. On his right is the oven for testing at 36° C.

(4) Easy analysis of the results, making possible rapid correction of any technical defects.

Tests are made on a statistical sample taken from each batch of watches produced, and checks are first carried out to ensure that components meet the decreed minimum quality specifications. These specifications may be changed with the introduction of new manufacturing techniques, so the system is flexible enough to encourage new production methods. Care has also been taken to ensure that the minimum quality requirement does not increase production costs. Thus, while the control process is concerned primarily with quality standards, the FH committee were conscious of the fact that it must also be an aid to economic production.

In addition to strict examination of the components, watches are rate observed in three vertical positions and in a horizontal position at a temperature of 20° C, and with two degrees of spring winding, for 24 hours. They are also tested at 36° C.

Working from these observations, calculations are made about daily performance, isochronal error, positional error and temperature error. It is a combination of these four criteria that constitutes what is known as the quality-index.

A quality-index number is given to each watch, ranging from 0 for a perfect watch up to 25 for the lowest admissible quality in a man's watch. For a complete batch of watches to be declared acceptable, the watch under test must satisfy the minimum standards laid down for its quality-index number. Alternatively, it must be given a fresh and acceptable index number.

UNIFORMITY OF ASSESSMENT

Control of watches is carried out at the Neuchatel centre as at the other nine control centres, but it is this centre only which is responsible for establishing the control standards and for compiling data on the overall test performance of watches. This centralization of control standard calculations is an important factor in ensuring uniformity of quality assessment throughout the country.

At Neuchatel and the other centres conventional timing machines are used at present to observe watch performance. The use of such standard and commercially available machines has enabled the control centres to be set up quickly, but now that the centres are established and working effectively, plans are in hand to modernize their equipment.

For example, it is intended to introduce timing machines based on the principle of electronic interval counting. These electronic instruments will automatically observe the performance of a watch in different positions and with the stipulated two degrees of winding, the observed results being recorded on perforated paper tape. The tapes from the various centres will then be forwarded to Neuchatel, where a computer will make the necessary computations, print the results on a test certificate and, at the end of each month, provide invoices.

For the test at 36° C, referred to earlier, watches are placed in a thermostatically-controlled oven of the type illustrated on the left in Fig. 1. The most up-to-date instruments are used to study the escapement of the watch and the gears and swing of the balance wheel as in Fig 2. When a defect is disclosed, a detailed analysis is made to ascertain its cause.

Indeed, the control centres are intended not only to pass or reject watches but, more helpful to the manufacturers, to discover the basic reason for any rejects. Each centre places at the disposal of manufacturers the services of a consultant watch expert who is often able to suggest improvements in production methods to eliminate further rejects.

The control centres are now geared to handle a statistical sample of 650 watches per day, so that the effective volume of watches which is being controlled by them is in the order of 10 million units per year. When the programme of instrument modernization has been completed, this figure will have been trebled.

For the moment, the work of the centres is on an optional basis, the manufacturer being at liberty to send his products to the centres and the centres returning them to him as soon as the tests have been completed. As the capacity of the centres expands, their sphere of control will increase and testing will become compulsory for some classes of manufacture.

QUICK ACCEPTANCE

Already, the manufacturers who have voluntarily submitted to the control system represent one third of the total value of Swiss watch production. A manufacturer whose products are consistently successful and uniform over a certain period of time is classified in a special category and less frequent checks are made on his watches. This procedure, introduced as part of the overall statistical sampling technique, serves as some sort of incentive to manufacturers to join the scheme quickly in order to reduce the proportion of their watches which will be required to be tested when the system becomes compulsory.

Another similar incentive is a record which is maintained at Neuchatel and makes it possible for a participating manufacturer to know at any time the quality level at which another manufacturer is operating. The spirit of competition, in terms of quality and precision, is strong among Swiss watch manufacturers.

It might be argued, with varying proportions of truth and self-deceit, that the example of the Swiss watch industry holds no lesson for any industry in this country. It might be argued that the unusual action of inviting government legislation is alien to the national character or to the spirit of free enterprise or, the age old chestnut, pride of craftsmanship; that, like cotton in Lancashire, the success of the watch industry is of public concern in Switzerland and government action is therefore justified; or that quality and precision are more important in watches than in most other products; or, finally and most cynically, that the Swiss watch is already so well established that this new development is little more than a publicity gimmick.

Such arguments, however, do not obscure the fact that the Swiss watch industry has shown that it is jealous of its own reputation and is keenly aware of the sales value, particularly the export sales value, of rigid and publicly demonstrated standards of quality. It has shown that it believes that quality control shall not only be done, but shall be seen to be done.

Studying the escapement of the watch and measuring the amplitude of the wheel.

Getting the Thin Seam Coal

The National Coal Board's current drive to mechanise coal production (ENGNG, 28 April, p. 602) is stimulating the manufacturers of coal mining equipment. Among them are Crawley Industrial Products Limited who have recently opened a new factory at North Dock, Llanelly, South Wales. At present, production at this factory is on a limited scale but it is intended that its 90,000 sq. ft of floor space shall be fully utilised as soon as possible.

One of the problems facing coal miners in Britain is the difficulty of winning thin seam coal economically. From the table showing the average thickness of coal seams in the different Divisions of the NCB, it can be imagined that a large number of coal seams are rather less than 3 ft thick. Now that mechanised coal cutting and loading is the only way of making many collieries an economic proposition, fresh thinking on thin seam mining has become necessary.

Realizing this, Crawley Industrial Products have concentrated on evolving equipment suited to this type of mining. Cooperating with the NCB, they have designed and produced the Crawley Midget Miner which has a normal output of 200 tons per shift in seams from 18 in to 30 in thick using the Longwall system.

A sensing device, developed by the Mining Research Establishment of the NCB, has now been incorporated in the Midget Miner. The basic principle of this sensing unit is the measurement of the density of the strata under the unit by a gamma ray backscattering technique. The density of coal being little more than half that of rocks (1·3 gm per cc compared with 2·1 gm per cc) the attentuation of gamma rays passing through them is very different and constant feedback to the Midget Miner enables it to excavate coal without damaging the cutters.

These cutters consist of four rotating boring-arms, as illustrated, each of them being 72° out of phase with the preceding arm. Coal is passed from one cutter arm to the next until it is eventually pushed on to the conveyor.

Since there are limitations to the use of the longwall system in very thin seams, the company also developed the Crawley-Wilcox Continuous Miner which is suitable for the room and pillar type of mining. This unit is based on a short wall cutting machine preceded by two augers, each 41 in long and from 22 in in diameter. The augers have 32 carbide tipped cutting bits and rotate in opposite directions.

The introduction of these two units—particularly, perhaps, the Midget Miner with its nucleonic sensing head—seems to bring nearer the age of remote control mining recently forecast by an NCB official.

(Above) The Midget Miner, and (lower picture) the Continuous Miner.

TABLE

Division	Weighted average seam thickness (in)
East Midlands	48
North Western	55
West Midlands	56
South Western	56
North Eastern	46
Scottish	44
Durham	39
Northern (N & C)	36

Flow in a Highly Automatic Laundry

Linen hire—to hospitals and hotels, as well as to industrial organizations—is rapidly becoming big business and, as such, is demanding modern, highly automatic production methods. An example of meeting this demand is the new linen hire laundry at Hanworth, Middlesex, the fourteenth to be opened by Spring Grove Laundries Limited, who have their head offices at 179 Spring Grove Road, Isleworth, Middlesex.

Most of the washing and drying equipment is Swedish-made to an American design—by Calor of Stockholm under licence from the Ellis Drier Corporation of Chicago—and has been chosen because it is the only fully automatic equipment on such a large operating scale. The plant consists of two 800 lb dumping washers, each divided into four 200 lb compartments and having full automatic control; two 54 in hydro-extractors, each with a capacity of 400 lb dry weight; one 72 in 200 lb dry weight gas-fired tumbler-drier, the largest in Britain; and two flatwork ironers of 4 and 6 rollers, the larger fitted with a discharge attachment for folding Rolomatic towels.

The handling equipment, some of it automatic, is designed to keep production flowing and to utilise the plant as fully as possible. Since the economic load for the bulk washing, drying and handling equipment is 200 lb, the plant is augmented by a more conventional washer, extractor and tumbler-driers for smaller loads.

As illustrated in the flow process chart soiled linen on arrival in the plant is unloaded by hand from the company's vans in the unloading bay and placed directly on a conveyor belt which feeds material to the sorting and weighing department on the first floor. First the linen is sorted into seven types of washing and placed on another smaller conveyor belt leading to the weighing station. At this stage, overalls, boiler suits and other industrial clothing which require degreasing are earmarked for dry cleaning.

The soiled linen is then weighed into 200 lb batches and discharged through hoppers into the washers on the ground floor. There is a system of warning lights to guard against the possibility of the weighing operator feeding a 200 lb mass of soiled linen to an unprepared washing machine operator.

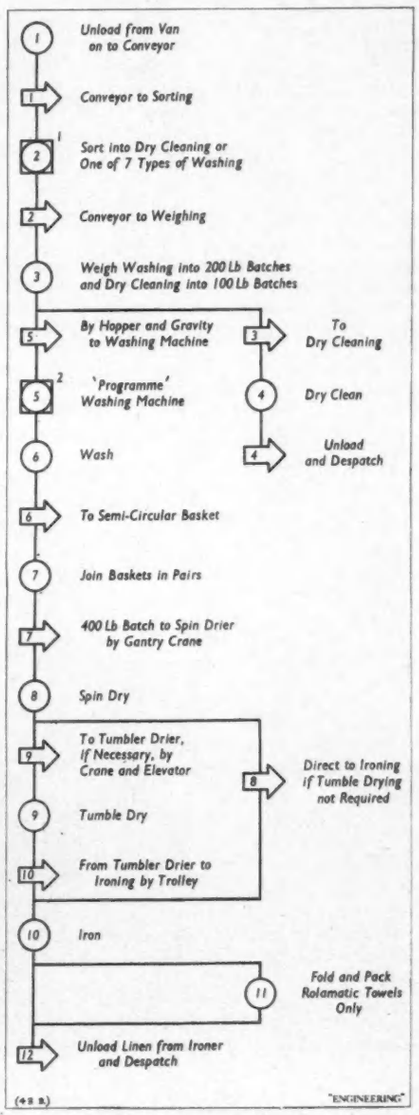
On the ground floor the washing machine operator can swing the hopper into position quickly and easily over the machine compartment by a single pull on a guide rope. As the linen falls into the compartment he notes which of the seven types it is and then programmes the machine to the appropriate washing system.

After washing, which normally takes approximately 55 minutes, a tipping device transfers the load of clean linen to half cylindrical metal baskets which are then joined in pairs to provide a 400 lb load for one of the two hydro-extractors or spin driers. These 400 lb loads are then loaded into a spin drier by a 1 ton remote-controlled gantry crane.

Spin drying usually takes 15 minutes, but tumbler drying is then necessary with some types of linen. Such articles are loaded by the crane into an elevator which feeds them directly into the tumbler drier where they spend about 4 minutes. The tumbler then disgorges the linen into trolleys which are pushed to the adjacent ironing section, where ironing is carried out mechanically on the two multiple-roller machines.

Thus, the turnover of linen is a speedy operation and no time is lost in recirculating it to the users. Nevertheless, the demand for the linen hire service has expanded so much that plans are already being made for more than doubling the existing production capacity. Provision has been made for such an expansion in the original design of the building and plant.

General view of the ground floor. The washing machines and their hoppers are against the far wall. The spin and tumbler driers are in the middle of the floor, and an ironer in the foreground.


1 Unload from Van on to Conveyor
1 Conveyor to Sorting
2 Sort into Dry Cleaning or One of 7 Types of Washing
2 Conveyor to Weighing
3 Weigh Washing into 200 Lb Batches and Dry Cleaning into 100 Lb Batches
5 By Hopper and Gravity to Washing Machine
3 To Dry Cleaning
5 'Programme' Washing Machine
4 Dry Clean
6 Wash
4 Unload and Despatch
6 To Semi-Circular Basket
7 Join Baskets in Pairs
7 400 Lb Batch to Spin Drier by Gantry Crane
8 Spin Dry
9 To Tumbler Drier, If Necessary, by Crane and Elevator
8 Direct to Ironing if Tumble Drying not Required
9 Tumble Dry
10 From Tumbler Drier to Ironing by Trolley
10 Iron
11 Fold and Pack Rolamatic Towels Only
12 Unload Linen from Ironer and Despatch
(42 B.)
"ENGINEERING"

The flow process chart.

Gardenmaster 85 Rotary Cultivator

The rapid success of Landmaster Limited in domestic power cultivation shows what can be done by a small but ardent team, backed by the resources of a large group.

PERHAPS the Gardenmaster could be more properly described as a "garden power source" since the better-known term "rotary cultivator" seems to be inadequate. Its success is due to both good engineering and an enlightened marketing strategy.

Though perhaps digging may safely be regarded as the Gardenmaster's basic function, it can perform a variety of other gardening and workshop tasks which depend on a source of rotary power, by means of simply-fitted attachments. Thus it carries versatility in domestic power cultivation a logical stage further.

The range of attachments for the Gardenmaster were not afterthoughts in any sense. Landmaster's design team decided at the outset on the duties of which the projected cultivator would be capable, and the Gardenmaster reflects full foreknowledge of these requirements.

Landmaster Limited, of Hucknall, near Nottingham, who produce the Gardenmaster range of equipment, are a subsidiary of the Firth Cleveland Group of companies—a group well known for the diversity of its interests. Other members of the family include such well-known names as Surform, Simmonds Aerocessories and Solartron, and so the Gardenmaster is in good company. The group's policy is to allow each subsidiary company reasonable autonomy in its own management, and at the same time to provide the necessary financial backing to ensure the success of any promising new development.

The Gardenmaster 80, introduced in 1957, would have been eminently suitable for Product Profile treatment had it not been for the recent success of the 85. Since its introduction last December, it has not only beaten the 80, but has become Britain's best selling domestic cultivator; so ENGINEERING chose the 85 for this article.

Digging with one for the first time is rather like taking hold of the hind legs of a giant burrowing beetle. Gently lifting up the handlebars transfers the weight to the digging head and results in a vigorous excavating action. Give a slight push and the machine will draw itself forward over the soil it has loosened, digging as it travels. There can be few engineering products so attractive in behaviour and at the same time so effective in performance. A nice balance has been struck between ease of operation and a stylish and functional appearance.

Its basic duty is to mechanize, or "give mechanical character to", the sometimes back-breaking human task of digging the garden. Before setting out to design a machine intended to perform any job normally done manually, a fundamental question must first be answered—how faithfully should the action of the machine reproduce that of a man? For the more closely the machine copies the human action, the more intricate will it become; and therefore the successful device is the one which makes use of the simplest mechanical action without undue sacrifice of effectiveness of the task.

For every kind of machine the final answer is different. To take an extreme example, in the Molins fliptop packaging machine recently featured in this series, exact reproduction of hand packing of cigarettes is essential to an acceptable packet product. The Gardenmaster 85 may be said to represent the other extreme, since its designers recognized that digging does not require a peculiar and sensitive action.

Fig. 2 The Kestrel, an early horticultural machine.

Something is wanted to cut, enter and loosen or remove the soil, and nothing more. There is no need to try to imitate a man using a spade since a plain rotative action using suitably shaped blades can dig very effectively. This fact is common knowledge today, and Landmaster's contribution to domestic power cultivation is to have introduced the protruding head principle.

DEVELOPMENT

When the garden cultivator was first introduced shortly before the war, it was essentially a one-purpose machine, like a lawnmower. Landmaster Equipment Limited, as the company were then known, did not enter the small powered cultivator field until 1950, when they brought out a 3½ hp machine with powered land wheel and rear rotary tiller, as shown in Fig. 2. This machine soon proved to be on the small side, and from 1952 onwards further machines with bigger engines and heavier drive arrangements were added to the range. They were intended more for horticultural than for domestic usage and their main outlet was Australia.

The idea of the protruding head principle, which lends itself so admirably to domestic cultivation by virtue of ease of control and versatility, came to Landmaster about the time of the company's acquisition by the Firth Cleveland group at the end of 1954. It was the brainchild of Mr. F. T. Clark, of Maidenhead, who had been trying each horticultural machinery firm in turn to find one willing to take up his idea. The late Mr. George Bryden, at that time

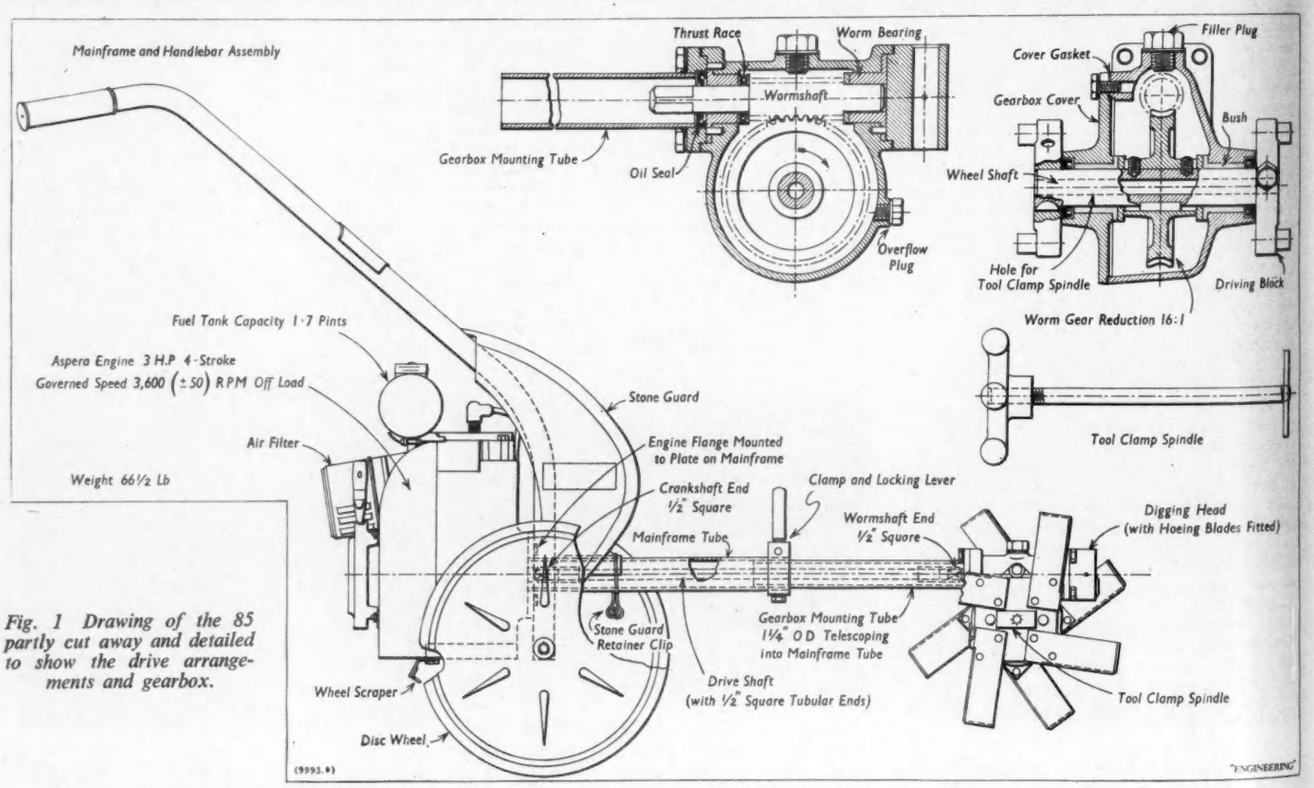


Fig. 1 Drawing of the 85 partly cut away and detailed to show the drive arrangements and gearbox.

Fig. 3 A new idea translated by energy and enterprise into a highly successful tool.

Fig. 4 (left) Changing over from hoeing blades to the rotary grass cutting attachment.

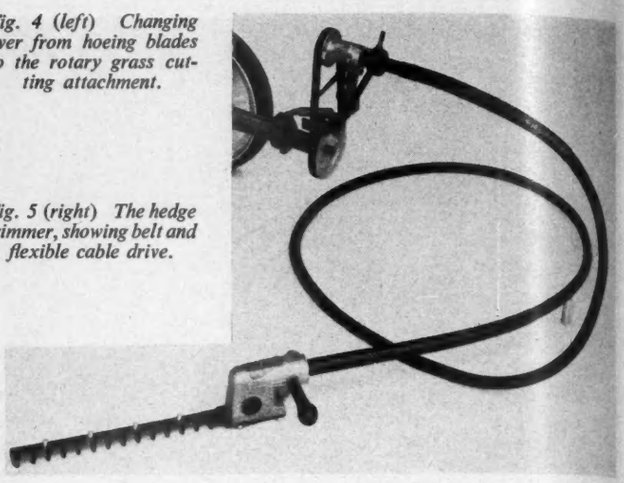


Fig. 5 (right) The hedge trimmer, showing belt and flexible cable drive.

managing director of Landmaster, immediately foresaw its domestic potential. He was responsible for obtaining the backing they needed to start design of protruding head machines and to manufacture them on a sufficiently large scale to make a successful entry into the domestic market; and also for taking out a patent.

Perhaps the most significant factor in these early days of the Gardenmaster machines was good management and sound planning, coupled with the realization of the immense possibilities in the relatively untapped domestic market. The machine was therefore designed as a quantity article with a definite retail price of £50 in view.

The two essential differences between the protruding head arrangement and the previous rear-drive cultivators are:—

(1) The " business end " protrudes well forward of the machine and its land wheels.

(2) The land wheels are not power driven.

The mechanical simplicity of the protruding head cultivator is evident from the drawing of the 85 (Fig. 1). The engine is a slighly modified Aspera type H 30 3 hp single-cylinder air-cooled 4-stroke. The crankshaft terminates in a square end, close to the base of the telescopic digging head tube. The digging head consists of a worm reduction gearbox bolted to the mounting tube and incorporating its own thrust bearing. The wheel shaft carries an elliptical driving block at each end for engaging with the digging blade hubs. The wormshaft also terminates in a square end, facing towards the engine. The drive shaft consists of square-section steel bar with a square socket welded at each end, and is sandwiched in between the crankshaft and the wormshaft in the working position.

The telescopic arrangement allows the digging head to be rotated through 90° to suit the spin weeder and lawn scarifier attachment. As there is no provision for positive location, the head can actually be rotated to any position around the circle. When turned to 180° from the normal position the machine digs backwards, without going over the soil it has just dug.

ATTACHMENTS

Directly the basic machine, eventually to be known as the Gardenmaster 80, had been designed it was time for production planning and development work on the various attachments. In the words of the company's home sales manager, the Gardenmaster " digs, hoes, weeds, trims hedges, cuts grass, mows and scarifies lawns, ridges potatoes, drills, grinds, polishes, pumps, and compresses air." And further applications are still being devised.

Production planning was carefully thought out. Market research specialists were called in and 1956 was spent in a critical study of the potential market. Landmaster emerged reasonably sure of an expanding market for the Gardenmaster, which would enable them to stabilise their prices by gradually expanding production; for example, in the UK alone there are over 6 million householders each owning his own garden.

The Gardenmaster 80 first appeared in 1957 at a price of £49. It has a 1½ hp JAP 80 cc 2-stroke petrol engine and, still £49, remains popular.

The Gardenmaster 34 is merely a smaller and lighter version of the 80 with a ¾ hp 34 cc 2-stroke engine, and came out later at £37 10*s*.

The Gardenmaster 85 is designed for the same duty as the 80, but differs from its predecessor in having a 4-stroke engine. The selling price is £49 with 12 in cultivation width. A " luxury " version of the 85, called the 95, is available at £59 10*s*. Landmaster are noticing a definite swing of public opinion in favour of a 4-stroke engine for small machines, which started in America; but they realise that there could be a reversal of public opinion back to a 2-stroke in a few years. By already having a big-selling 4-stroke machine on the market, and also offering a 2-stroke, they will be at an advantage. Furthermore, each attachment will fit any machine.

Introducing the 4-stroke engine in the 85 without exceeding the retail price of the 80 represents a considerable achievement. The torque from a 2-stroke engine is especially suitable for digging, and to obtain the required power from a 4-stroke meant increasing the cubic capacity.

To offset the greater cost of the 4-stroke engine, certain " frills " have been left off the 85, which might now be criticised on the grounds of oversimplicity. For instance, unlike the 80, it is not possible to adjust the handlebars for height. The throttle control has been taken away from the handlebars and placed on the engine.

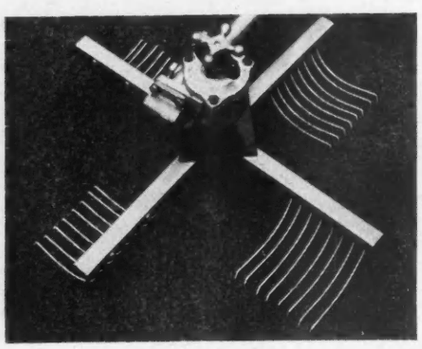


Fig. 6 Lawn rake showing head turned thro' 90°.

When digging with the 85, all the operator has to do after fitting the correct blades and setting the throttle is to guide the machine, and strike a balance between downward digging and forward travel according to the depth of penetration he requires. The tendency with present-day engineering equipment to increase the number of controllable variables does not always pay.

The Gardenmaster's most important technical feature, the protruding head, is not an easy one to put over. So it was decided to try showmanship—unusual in selling engineering products generally. At agricultural shows and exhibitions, both music and costume have successfully been used to draw a crowd, in conjunction with a live Gardenmaster demonstration.

Advertizing is distinctive and to the point. Humorous play is made of common but fictitiously named gardening ailments, such as " digtheria," for which the Gardenmaster is offered as a permanent cure.

Landmaster know that a tremendous potential market exists for the Gardenmaster both at home and abroad, and that up to the present the surface has hardly been scratched. Selling a tool of this kind is most effectively done by live demonstration, usually in the customer's own garden so he can see there are " no tricks," and often outside normal working hours. The dealers themselves are authorized to sell Gardenmaster equipment only if they are prepared to offer full service facilities, since after-sales service is an essential ingredient of success for a motorized domestic tool.

Normal production problems associated with a seasonable business are accentuated due to cramped quarters, and new premises are urgently needed. Landmaster employ about 150 at Hucknall, spread out between two old factories and a converted aircraft hanger. Fortunately some of the Gardenmaster's components, in particular the welded sub-assemblies, are manufactured by other members of the Firth Cleveland group, and all engines and castings are bought out. Elasticity is the keynote of production, and the company were able this season, at extremely short notice, to treble the planned production of the 85, while still increasing the production of other models. All previous production records have recently been beaten.

Apart from the domestic range, Landmaster also make a highly successful horticultural cultivator and a tractor-mounted rotary tiller.

The outstanding success of the Gardenmaster, which has so handsomely exceeded its planned expectations, is only the beginning of the story. The day is not far distant when using a domestic cultivator will be as commonplace as using a vacuum cleaner.

Marketing

Machine Tools Set An Example in Exports

PRODUCTION in the machine tool industry in 1960 rose by more than twice that of mechanical engineering generally. The Machine Tool Trades Association reaches this conclusion comparing the index of industrial production, which gives a rise of 10 per cent over the year for the mechanical engineering industry, with the corresponding figure for machine tools—21 per cent.

In the export success achieved by the industry its relative position is even better. Against a general export improvement by the United Kingdom of 6 per cent during 1960 the mechanical engineering industries recorded an increase of 14 per cent and machine tools one of 31 per cent.

Substantial, and increasing, orders are coming in from Australia, India, West Germany, Sweden, Italy and Japan (in that order) and each country is responsible for more than 5 per cent of the present order book of the industry.

Export deliveries during 1960 rose much more sharply over 1959 than the level of all deliveries. Last year's export deliveries were worth £24·3 million (1959 £18·5 million). Home deliveries were £70·6 million (£60·2 million).

The emphasis was not the same in the order book at the end of the year. Export orders were standing at £24·3 million (against £15·7 million) while home orders had risen from £40·1 million at the end of 1959 to £81·4 million.

Employment in the industry has hardly changed despite the higher level of activity. The labour force in the machine tool manufacturing companies has in fact risen less than two per cent, to 44,000.

Gnome Engines for Royal Swedish Navy

Boeing-Vertol 107 and Italian built Agusta-Bell 204B helicopters used by the Royal Swedish Navy are to be powered by Gnome engines manufactured by the DE HAVILLAND ENGINE Company, part of the HAWKER SIDDELEY group. The contract, worth £1 million, was signed recently in Sweden and is the first to be negotiated in the European Free Trade Association. Within the last four months the first £1 million contract for the sale of helicopter turbine engines to a country within the European Common Market was concluded by the company. This was to supply Gnome engines to the Agusta Company of Milan.

The decision to use the de Havilland Gnome on the Boeing-Vertol 107 would be of substantial importance for future orders. In the United Kingdom, West Germany and Japan there is considerable civil and military interest in this helicopter.

Gnome H 1200 engines will be delivered to the Vertol division of Boeing later this year for military and civil approval tests. They are at present in volume production for the military and civil Westland Whirlwind Mk 10 general purpose helicopter and also the Westland Wessex which is to be used for Royal Navy anti-submarine and commando operations.

Low Cost Computer For Builders' Distributor

The copper tubes and fittings distributors BUILDERS COPPER TUBE—part of the METROPOLE INDUSTRIES Group—are to use a Ferranti Sirius computer for commercial data processing. The computer will be installed at the company's head office and used for stock control, invoicing and sales and cost analysis.

Head offices of the company are a mile away from the warehouse, which carries some 5,000 items of stock. A teleprinter link will keep the two in contact, enabling the computer to keep up to date with the stock position, sending out invoices and giving re-ordering instructions to the warehouse.

Information, on paper tape, will be produced by the computer and sent by teleprinter to the warehouse where it will be printed on conventional invoice forms and advice notes. Printing will also be done at the head office at the same time.

In order to deal with individual enquiries, it will be possible to interrogate the computer to find the amount of any particular item in stock.

The Sirius computer, with a power consumption about that of a normal domestic electric fire, weights 13 cwt and occupies only 25 sq. ft of office space. The use of a simplified language for instructing or programming the machine, Autocode, makes it possible for people not specifically trained as computer programmers to use the equipment.

Total cost of the installation will be under £30,000.

Air Conditioned Concrete Laboratory

The extensions now being made to the Imperial College of Science and Technology, London, include a new concrete curing and testing laboratory where experiments are to be conducted on the setting of concrete under varying atmospheric conditions.

Close control of temperature and humidity will be assisted by a central station air conditioning plant which should be installed within the next three months. The air conditioning contract has been awarded to TEMPERATURE Limited, of London, SW.

Skelmersdale New Town Aerial Survey

An area of 1,730 acres between Liverpool and Wigan, Lancashire, is to be photographed and mapped from the air, as part of the Skelmersdale New Town project. FAIREY AIR SURVEYS Limited are to do the work for the Ministry of Housing and Local Government. The survey will be an extension by Fairey of the work they did on the Skelmersdale district for the Lancashire County Council from October, 1959, to May, 1960.

From their photographs the company will revise existing maps on the 1/2,500 scale with the addition of contours at 5 ft vertical intervals. Fairey surveyors working on the ground will make detailed height measurements as a basis for 1/500 plans if they should be required later by the development corporation for the new town.

A Business Diary Of the Leipzig Fair

Contracts concluded by United Kingdom firms with East German organizations at this year's Leipzig Fair were worth £5·4 million, 50 per cent more than the £3·6 million of the 1960 Spring Fair. Substantial orders were received for steel products and for machinery.

East German orders with British steel firms came to a total of £487,000, which included contracts worth £150,000 with BRITISH ROPES, of Doncaster, £120,000 with GRAHAM FIRTH STEEL PRODUCTS, of Walsall, and £60,000 with TI (Export), of Birmingham. The ENGLISH STEEL CORPORATION, of Sheffield, received two orders from Yugoslavia.

Injection moulding machinery worth £68,000 was ordered from R. H. WINDSOR, of Chessington. Cranes and building machinery were ordered from RANSOME AND RAPIER, of Ipswich, K & L STEELFOUNDERS AND ENGINEERS, Letchworth, STEELS ENGINEERING PRODUCTS, of Sunderland, AVELING-BARFORD, of Grantham, and MARSHALL SONS, Gainsborough.

Airport ground equipment by Pye, centrifugal and process equipment by SHARPLES PROCESS ENGINEERS, London, and bottle topping machinery by FORDS (FINSBURY) of Bedford, were also among the East German orders. £300,000 worth of paper-making machinery was bought from Millspaugh, the Sheffield company.

There were sales in both directions of toys. British purchases in East Germany make a varied list, from printing machinery and £200,000 worth of cameras, to 100,000 bicycle chains and unit furniture and musical instruments.

Overall business done at the fair, which ran for ten days, a good deal shorter than the 17 days favoured for the big British efforts by the Federation of British Industries, was 11·5 per cent up on 1960's Spring Fair. This increase is fairly close to the increase over the previous year in East German export figures—10·2 per cent; imports have risen in value by 15 per cent.

Among the 630,000 visitors from 90 countries who attended the fair were 50,000 from Western states, 1,000 of them from Great Britain. The Leipzig Autumn Fair, which is primarily an affair of consumer goods, is to run from 3 to 10 September.

An X-Ray Bomb Detector

There have been enough explosions in aircraft and on board ships attributable to deliberately placed explosives for detection apparatus to be worth introducing.

NOW the WESTINGHOUSE ELECTRIC CORPORATION have developed a portable X-ray inspection unit to detect bombs or booby traps in packages. The device uses fluoroscopic and radiographic means.

Continuous protection of highly placed much travelled officials is envisaged by the producers of the unit. Police, prison, postal and other security personnel are likely users and the equipment has the advantage of working off normal household electricity supplies.

Care has been taken to provide full protection for the operator against radiation. It is possible to imagine that, in time, airline passengers will have to add going before the bomb detector to their present list of departure and arrival chores.

The detector gives a picture of the package contents being examined. Weighing 160 lb, the units include X-ray tube, viewing hood and protective shielding.

First Exhibit in Place At Moscow Trade Fair

One of the first exhibits to reach Moscow by road for the British Trade Fair later this month is now the first to be installed. It is the 6 MeV linear accelerator—LINAC—designed by VICKERS RESEARCH for super-voltage therapy in hospitals.

A new approach to the super-voltage X-ray machine, the Vickers X-band linear accelerator uses the first commercial seal-off accelerator tube, which is now being produced by Vickers. It also has miniaturized and packaged equipment so that auxiliary apparatus is not needed and the accelerator can be housed in a treatment room with a control station.

Raising the Cash for Rover Car Expansion

The ROVER Company are to increase their authorized capital to £5,500,000 by creating four million new 5*s* Ordinary shares in preparation for a rights issue to raise some £2 million to be spent on expansion of capacity.

Most of the capital required for the company's capital programme is expected to be provided from internal resources plus temporary bank facilities. The terms of the rights issue are to be made known later.

Dry Drilling at The Moscow Fair

Taking part in the British Trade Fair in Moscow next month will not exactly be a new departure for HOLMAN BROTHERS, the Cornish mining engineers, or their subsidiary the CLIMAX ROCK DRILL AND ENGINEERING Company. Both companies were carrying on a lively business with the Soviet Union as separate enterprises in the early 1930's.

Holman will be showing in Moscow the Holman Holtrac, a crawler mounted drill rig. With a towed air compressor this forms a self-propelled unit able to be operated by one man. The middleweight of the Holman Rotair range, the 370 portable rotary screw compressor will be there. As with all Rotairs, the 370 has only six moving parts in its basic compressor unit and gives high performance with no demands for maintenance.

Sub-zero temperatures in the Soviet mines mean that dust suppression by passing water through the hollow drill steel is not possible. Holman have taken care of this problem by devising the Dryductor. This machine drills in the normal manner for pneumatic percussive drills but dust and chippings are drawn through the hollow steel and out through the back of the machine into a container.

A Dryductor will be among the rock drills exhibited among the Holman products.

On the Shelf

By Frank H. Smith

I SEEM to remember mentioning a publication of Space Technology Laboratories Inc., Los Angeles 45 (Cal, of course), called *Live Deadlines* which gives forthcoming meetings, the date papers have to be in and so on. They have, I am pleased to see, altered their format so that the booklet is smaller and more convenient, but I am shaken to my foundation garment to see that in a foreword by Jimmy Doolittle there is a phrase " It is therefore suggested that you give serious consideration to the idea of presenting more of your work to scientific and technical gatherings throughout the country."

The Society of Indexers is a comparatively small but most active body, and they have now arranged for a course of lectures on indexing at the North Western Polytechnic (Prince of Wales Road, London, NW5) from 6 October to 8 December (and you cannot say you have not had plenty of notice). 10 lectures for 21*s* (or 2*s* 6*d* a lecture) seems most reasonable to me, and I'm all in favour of any movement to produce more (and better) indexes. For the course, further information is obtainable from Mr. G. Norman Knight, 3 Western Mansions, Western Parade, Barnet, Herts.

As my readers will know, I'll always give a boost to anything that bears the remotest resemblance to a bibliography. No. 25 (1960) of the *Mitteilungen aus dem Max-Planck-Institut für Strömungsforschung und der Aerodynamischen Versuchsanstalt* (Gottingen) is " Bibliographie der Veröffentlichungen über Hydro- und Aerodynamik," and a heap more to the title giving the bodies covered but it will fill the whole column for one week. The period covered is 1907-1959, which is quite a bit of H- und A-dynamik.

From a Deutscher Normenausschuss, Berlin, W15, Uglandstrasse 175 (the German Standards folk) kommt " Information für die Presse " that they have established a special department to prepare translations of German industrial standards in English. 1200 translations have so far been gemacht. New lists are obtainable free from the address quoted. The list gives full information on how to obtain the standards and carries a modest disclaimer for the accuracy of the translation.

Cumulative catalogues from publishers are always a joy. So many bits and bobs of leaflets, spring and autumn lists can be thrown away that the shelf holding them (barely, more often than not) looks quite naked by the time you've finished. Such a one comes from Interscience Publishers Limited (88-90 Chancery Lane, London, WC2) for 1961 and it celebrates 20 years of publishing.

Not exactly a bibliography but a jolly useful list is *List of Publications on Structural Sandwich, Plastic Laminates, and Wood-Base Aircraft Components available from the Forest Products Laboratory, Madison 5, Wis., USA.* The last three letters are not actually in the title but I put 'em in to show you how foolproof I make you. The list runs to 14 pages, conveniently divided into subjects.

Microcard Editions Inc., 901 26th Street NW, Washington 7, are taking orders (at $4) for *Guide to Microforms in Print 1961.* There are 10,000 entries covering 41 publishers.

The Petroleum Films Bureau (29 New Bond Street, London, W1) has just issued its 1961 catalogue of film available for (mostly free) borrowing. If you want supplements you have only to ask, and a new catalogue will appear in 1963. Incidentally, those of you who wonder why the oil people dish out these lovely free-hire obs may like to know that in the latest British Petroleum *News Letter* it is pointed out that five BP films now on release in Great Britain have, between them, been shown to 17 million people.

Guided Missile Complex

Systems Preliminary Design. By JOSEPH J. JERGER. *Van Nostrand, Princeton, New Jersey, and London.* (110*s*)

The programme of preliminary study which precedes the detail design of a guided missile and the interdependence of the many engineering disciplines essential to the successful development of a modern weapon system are examined in this book, which is one of a series entitled " Principles of Guided Missile Design."

A more descriptive title for this volume, from the British engineer's point of view, might be " The Art of Project Design." The essence of an intelligent preliminary study of any military guided missile project is the realisation that the weapon itself is but one part of the system, a carrier of a warhead the function of which is to destroy a target. Many factors external to the missile will determine the success of its mission: the manoeuvrability and vulnerability of the target, the stability of the launcher, the response of tracking and control equipment and the lethality of the warhead are but a few. All of them must be taken into account by the systems engineer.

Naturally, and commendably, Mr. Jerger takes pains to stress these aspects in the first part of his book but it will no doubt surprise engineers in this country to find that he then devotes one chapter exclusively to system reliability, showing how it can enter into preliminary design calculations. It is to be hoped that this statistical approach will find greater support in all fields of engineering design.

Although the title suggests a very general discussion, the treatment, in fact, is restricted to beam-riding, command guidance and homing missiles. Further, no descriptive detail of target sensing equipment is given in the text as this subject has been covered adequately by another book in the series—Locke's *Guidance.*

Following the introductory chapters on weapon missions and reliability, the author continues with stability and control, kinematics and missile performance assessment, and concludes in a manner quite rare in the literature: a complete preliminary analysis of a hypothetical ground-to-air missile for which he has taken a sensible specification as a basis for numerical evaluation. In fact, throughout the book, examples are included wherever possible and, in nearly every case, solutions are determined without recourse to computers, so much in favour these days, to handle calculations which, with a little thought, can be treated satisfactorily by hand.

The author has found it necessary to insert two further chapters on heat transfer and structures in order to complete the groundwork for his final exhaustive example. These two aspects are, of course, essential to any preliminary analysis but the reviewer believes that their omission from this volume would be justified. The theory and data presented on structures are more than covered by standard texts to be found in any technical office of the aircraft industry.

For example, no project engineer should need four pages detailing the derivation of bending-moment and shear diagrams for simply supported and encastré beams. Again, there is an appendix to this chapter giving strength data for various alloys to American specifications. Such data serves only to expand a book which, for reason of its ambitious subject, is necessarily large and fairly expensive.

But detailed knowledge of the subject matter of these chapters is not essential for application of the methods of analysis so excellently presented elsewhere in the text.

The section on kinematics is especially well done. Algebraic relationships are linearized by propitious yet reasonable simplifying assumptions to allow their immediate application in the systematic derivation of performance parameters without introducing the transcendental functions of mathematics. For this reason the volume can be recommended both to the project engineer as a reference and to other workers in the missile industry who wish to gain a broader view of their chosen field.

B. STEWART

Five Steps to National Maturity

The Stages of Economic Growth. By W. W. ROSTOW. *Cambridge University Press.* (21*s*)

Professor Rostow shows that a country may be in one of five stages of development. The first is a traditional agricultural society, in which the inaccessibility of modern science sets a ceiling to productivity. The second is a transitional society in which the foundations of change are being laid, following the emergence of factors which enable (*a*) a new élite to appear which has the urge towards modernization and (*b*) 5 to 10 per cent of the national income to be devoted to investment.

The third stage is a " take-off " period of a few decades, when the economy transforms itself so that growth becomes more or less automatic. China, India, and Turkey are " taking-off " today.

At the end of the take-off the new modern élite is in full and confident power: the fourth stage. Britain after the Napoleonic wars, the USA after the civil war, Bismarck's Germany after 1870, Stalin's Soviet Union of the five year plans from 1928, were all societies run by men who knew what they wanted. These were, broadly, all confident periods, with big tasks which quickly showed results, and the society, willingly or reluctantly, gave its industrial leaders their head.

Nevertheless, the process has within it the seeds of its own modification. Advancing maturity increases the proportion of white collar workers, highly trained technicians, and professionals, who see that by organizing they can achieve higher real wages and security. Thus, the process of maturing generates new kinds of social pressures which lead to humane modifications—for example, the British Factory Acts of the 1840's, Bismarck's social insurance laws, Lloyd George's National Insurance Act, Roosevelt's New Deal, and the incipient concessions to consumers and technicians in the USSR since 1953. This fourth stage is in fact maturity, reached about sixty years after the " take-off."

Maturity is dangerous because it brings three choices: Should the country go on, as the USA did in the early 1920's and as we did in the late 1930's (interrupted by the war) to the fifth stage of mass consumption? Should it work less hard, become a welfare society? Should it use its new resources to seek, by war if necessary, external power?

Wars arise because people accept that national sovereignty ultimately gives the right to kill foreigners in pursuit of what are judged to be national interests. This concept is a hangover from the world of traditional societies. Professor Rostow distinguishes three kinds of war.

First there are colonial wars, arising (*a*) from foreigners' intrusions on traditional societies, (*b*) when colonial power becomes a symbol of international status, as between 1873 and 1914, and (*c*) from the bids of colonial peoples for independence.

Next there are limited regional wars, arising as new states in the early stages of modernization look back to humiliations and forward to new opportunity.

New leaders struggle with the task of consolidating unstable societies undergoing the divisive social stresses of transition. They owe their leadership to nationalist feelings born of

reaction against foreigners. Their new nationalism may be turned outward to right real, or fancied, humiliations or to opportunities for national aggrandisement, which temptingly appear for the first time within grasp. Or nationalism can be turned inward to pressing economic, social, and political advance, against the resistances of the old regionally based traditional social structure.

Once modern nationhood is established, different groups urge the newly triumphant nationalist sentiment in different directions: the soldiers, say, abroad; the politicians to consolidate the hold of the centre over the region; the merchants to economic development; the intellectuals to social, political, and legal reform. Regional wars can be used to maintain national cohesion in an emerging society threatened by internal conflicts, hence the belligerence of a Nasser or a Sukarno, and the battle cries heard around Kashmir and Israel.

Finally, Professor Rostow sees massive wars arising from attempts to win hegemony in the Eurasian or world arena. He attributes the massive aggressions of Germany, Japan, and the USSR to their heritages of "reactive nationalism" which helped to create each.

To the extent, then, that the twentieth century's great struggles for power have an economic basis, it lies not in Marxist compulsions arising from an alleged monopoly stage of capitalism but in the contours of the Eurasian arena of power, as determined by relative stages of growth, and particularly in the temptations and fears presented to new mature powers by the instability of the transitional societies in eastern Europe and Asia.

The USSR is now such a mature power. Will it seek high consumption or world hegemony? That China and India, and other states in transition, will be elbowing their way to the dangerous age of maturity within this century is relevant to the answer, which is that the West's task is simultaneously to make by its alliances the choice of world domination unattractive and the choice of high consumption as easy and face-saving as it can.

If the free West has a head start in industrialization, it has no monopoly in it, and the only way to peace is to face the implications of world growth and to be generous in development aid in order to try to canalize world forces to constructive ends. Since the USA cannot carry the burden alone, one concludes that the democracies should draw up a single, coordinated, major plan for continuing aid, and should recognize the need actively to promote the evolution of their own economies so as to allow liberal imports of manufactures from the developing countries.

If the non-Communist leaders in those societies, struggling in transition, are to turn from external adventure to internal advance, they must be able to rely on aid continuing over a definite period that enables plans to be carried out.

They cannot, as India has done since her first five year plan, live from day to day, out of one financial crisis into another.

What is new about all this? Any summary of a closely reasoned book that ranges over the whole world must result in generalizations so broad as to seem glimpses of the obvious. Everyone recognizes the connection between the problems of the cold war and the need to aid the developing countries of Asia and Africa, but Professor Rostow assembles the facts under one cover, brings out their full implications, and argues that, provided the West remains united in deterring violence and in promoting aid, neither war nor the triumph of Marxism is inevitable.

JOSSLEYN HENNESSY

Cloth and Kinematics Interwoven

Mechanics for Textile Students. By W. A. HANTON. *The Textile Institute, Manchester; Butterworths, London.* (30*s*)

Textile machinery design often involves the production of a mechanism which has to meet a user's detailed specification. As a result, what is often called " theory of machines " is of unusual importance, both to the textile engineer and to the machine user. In fact, kinematics lies at the heart of much textile machinery design, with the strength of the various members being dictated by considerations of maximum deflections allowable. It is therefore hardly surprising that a textbook on mechanics for textile students should consider a study of movement before considering the forces that produce this movement.

The book under review is a photolithic reprint of a work previously published by the Textile Institute, Manchester. It still remains the only textbook of its kind and consequently is invaluable as an introduction to the applied mechanics of textile machinery. It is, however, no textbook in elementary mechanics, even though it requires no knowledge of the calculus. Despite its elementary nature, it assumes a knowledge of the basic ideas behind the fundamental equations used. In fact, in the introduction the author points out the necessity for reference to standard texts on mechanics. The book is in fact very similar to many textbooks in theory of machines which take the elementary mechanics for granted.

No attempt can be made in an elementary textbook of this kind to consider the validity of the criteria upon which many of these mechanisms are based. In an industry where craft methods are still used, the machine designer is often compelled to follow tradition as his only guide to the specifications his mechanism must meet. Being outside the craft industry, the machine maker tends to become dependent on the industry for his ideas regarding modifications. In fact, all the textile machinery makers are very closely allied to some branch of textile manufacturers, and very dependent on them as a source of new ideas and inventions.

It is highly desirable, therefore, that the designer of textile machinery and the user should know as much as is reasonably possible about each other's subjects, as only from such a pooling of knowledge can a more exact understanding of textile processing come; and, moreover, without such an understanding a more rational approach to textile design is impossible. This book is meant primarily as an introduction to such a study by the users of textile machinery.

A large field of textile machine design has been covered in this work, mainly by means of very numerous examples. It is hoped, however, that as there appears to be sufficient demand to call for a reprint of this book, a further revised edition may soon be possible. If such a revision were to be undertaken it would be a pity if the examples were not to be extended to show the interplay between the behaviour of the textile and the mechanism, as in the movement of the cloth fell in the loom.

Such an extension would make the book invaluable for professional examinations such as are conducted by the Textile Institute and the Institution of Mechanical Engineers, for which there is a great need. By such an extension the present volume, which is probably written with the technical college student in mind, will serve a greater range of textile students for whom no similar work is at present available.

The photolitho process by which this book has been produced at an economic price is not altogether successful. The many diagrams have become much more difficult to follow and some of the lettering on the graphs has become illegible.

PERCY GROSBERG

Philosophy of Water Control Structures

Irrigation and Hydraulic Design. By SERGE LELIAVSKY. Volume III. *Chapman and Hall.* (£13 13*s*)

Now that the third volume of Dr. Leliavsky's monumental trilogy is put before us, we are reminded again of the author's individualistic approach to his wide-ranging subject. Indeed, one could hardly have expected an orthodox treatise from an engineer with so distinctive a career.

Working first on large hydroelectric schemes on the river Dnieper, then assisting in projects for controlling the Nile, teaching Egyptian students who in their turn might help to control the river, and now in these massive volumes giving to the technical world the fruits of his experience—such an author would be likely to throw an original light on anything he wrote about.

Although, as Dr. Leliavsky explained in his preface, it was his aim to create a work of reference that would always lie on the designer's desk, that did not imply that he was concerned only with sets of rules and tables and diagrams. Nor did he set out to compile an encyclopaedia. His role was to be a more expansive one. Quite literally, he wanted to be the reader's guide, philosopher and friend.

In this third volume of the series, he offers to the reader " a much wider field of opportunity for the exercise of the creative engineering genius." Guidance is to be presented " in the form of a descriptive and analytical comparison of various types " of structures, and the application of this teaching will call for " greater maturity and deeper insight " than formerly sufficed.

Instead, then, of trying to deal comprehensively with all possible kinds of structure and component that might fall under the heading of Hydraulic Structure, the author has selected for treatment those on which he feels particularly able to advise. On these chosen subjects he is therefore free to lavish detailed attention, and to devote to them a leisurely examination which will be enriched by his historical and philosopical outlook. Their overall range is indicated by the chapter headings: Diversion Headworks on Alluvial Rivers; Locks; Arches; Dams; and the Electrification of Irrigation Works.

In the most logical way, the first section of Volume III poses the question: are diversion headworks on rivers necessary at all? Instead of building these costly weirs or barrages in order to divert water into a canal which will ultimately deliver the water to the areas to be irrigated, might it not be more economical to lift the irrigation water directly from the river by pumps? But having exposed the economic basis of the comparison, the author thenceforth confines himself only to one solution—that which embodies free-flow irrigation. He is not to be distracted by the pumping stations that will be

indispensable if free-flow irrigation is uneconomic or impracticable.

Yet pumps are not ignored. In Section 5 they are described and illustrated, as necessary adjuncts to the dewatering of the river bed before the floor of the diversion barrage can be laid. The sequence of constructional operations is explained in full detail, and it follows naturally upon the account of cut-off devices beneath the floor that occupies an earlier section.

As for the final problem, how to make the barrage structure " operational " by providing it with movable steel gates, there is a most comprehensive section which shows what a diversity of types is available. Here also we get a hint of one of the author's major and most fruitful preoccupations—the analysis of vibrations in engineering structures.

It is in the chapter entitled Dams—a chapter which, as it runs to nearly three hundred pages, can itself be regarded as a self-contained treatise—that Dr. Leliavsky makes his outstanding contribution to the study of hydraulic structures. As he tells us, his approach to the subject of concrete and masonry dams is that of an irrigation engineer, and especially an irrigation engineer deeply interested in the control of the River Nile.

Here are no terse instructions on how to build a dam. We rather feel ourselves to be in the presence of someone with a profound sense of the responsibility that weighs on all who take any share in dam construction: expositions are informed by prolonged philosophical reflection. Noteworthy are the sections devoted to shearing stresses in gravity dams and to the movements of dams under the influence of thermal changes. These sections, as well as the one which analyses the allowance to be made for uplift, are given additional authority by detailed accounts of the author's own experiments.

Suddenly, as the reader passes from the consideration of gravity dams to the principles that underlie arch dams, he may feel the chill of tragedy. He will notice the sombre manner in which recent events have overtaken Dr. Leliavsky's expositions. Various types of arch dam, we read, " are nevertheless entirely safe, and perform perfectly well their various duties. In fact, none of them has so far collapsed, or shown any signs of serious trouble." Such words could justifiably be chosen at the time they were written, but after the disaster at Malpasset in December, 1959, readers may interpret them less confidently. If, in this frame of mind, they pass on to the sections of the volume that describe dams that depend for their stability upon prestressed steel cables, could they be blamed for wondering what will have happened to the cables in fifty years time?

Returning finally to the author's own outlook, it is characteristically reflected in the heading of the last page of the two thousand odd pages that constitute this great trilogy: " Original tendencies in power house design." These words give one more guarantee that Dr. Leliavsky's insight and lively curiosity will direct him to advanced theories and methods, wherever they may be found. That is why, in 130 pages that fully describe hydroelectric developments, we find a most valuable analysis of vibrations in such installations, and an account of the most recent type of water turbine—the " bulb " or " tubular " turbine.

Like its predecessors, this third volume is superbly illustrated and produced. In assessing its value it ought not to be considered alone. The three volumes in their entirety are the work of one man. Dr. Leliavsky is not merely the editor who collated the contributions of a team of writers. He wrote it all himself. He himself amassed the remarkable range of material that is displayed in his pages. It is an achievement on a heroic scale. It should earn for him the warmest congratulations of everyone who knows just what an effort the trilogy represents; it will win the gratitude of civil engineers throughout the world who will regard it as a treasure-house of knowledge and of wisdom.

HERBERT ADDISON

Elastomeric Polymers Applied

Synthetic Rubber Technology. By W. S. PENN. Volume 1. *Maclaren and Sons.* (50*s*)

The development of synthetic rubbers has been the work of chemists and physicists—academically trained men used to the collection and organisation of scientific information. Hence much of the post-war literature on elastomeric polymers has described the chemistry and principles of manufacture of the raw rubbers rather than the technology of their compounding and application.

W. S. Penn is manager of the synthetic rubber and plastics division of Richard Klinger Limited. He has held senior positions in development and production with Henley's Tyre and Rubber Company Limited, British Insulated Callenders Cable Limited, and Johnson and Phillips Limited. Although a scientist by training, he has for many years been handling and using rubbers and rubbery thermoplastics. Recognising as the result of experience, the widespread need for reliable practical information, he has collected and collated in this 325 page volume data from technical journals, trade publications and personal experiment. He has confined attention to varieties of the following types of commercially available rubbers: SBR, high styrene resin-rubbers, butyl, nitrile, neoprene, silicone and thiokol. A second volume is to be devoted to more specialized products.

The author describes available grades of each polymer and how they are compounded, processed and used in a variety of industrial applications. The book is for reference: numerous tables of numerical data make digestion difficult. It would be unwise to assume that the reader would obtain closely similar physical test results if he attempted to duplicate a particular mix and cure. One feels that in many instances graphs could have replaced pages of tabulated numbers to convey information more effectively.

When students are so often criticised for bad English it is unfortunate that Mr. Penn has not more carefully edited his script. Many passages have to be read several times before their meaning emerges. There is more excuse for anomalies clearly due to the varied sources upon which the author has had to draw.

The volume is well produced and indexed; but understandably not illustrated. It will help the man in the works, as well as students at all levels: workshop practice, licentiateship and associateship.

F. H. COTTON

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Company Activities

Project Engineering. THE POWER-GAS CORPORATION LTD., Stockton-on-Tees. The complete project engineering and erection services offered by the company are described for process plant and civil engineering contracts. Brochure, 34 pp. ill.

Servicing Equipment. MORFAX LTD., Willow Lane, Mitcham, Surrey. Ground servicing equipment for aircraft, including working platforms, engine dollies and transport stands. 8 pp. ill.

Contract Engineering. NEGRETTI AND ZAMBRA LTD., 122 Regent Street, London W1. Contract engineering facilities for instrumentation. Metal and plastic panels, instruments, piping and wiring. Publication C100. 12 pp. ill.

Railway Track. THOS. W. WARD LTD., Albion Works, Sheffield. " Rails and Rail Accessories " catalogue now in 6th edition. Includes rails, turnouts, levers, crossings, turntables, stops, and platelayers tools. Standard and narrow gauges. 32 pp. ill.

Glassware. GRIFFIN AND GEORGE LTD., Ealing Road, Alperton, Wembley, Middlesex. Volumetric and lampblown glassware; including flasks, beakers, burettes, pipettes, extractors, and viscometers. Catalogue, 54 pp. ill throughout.

High Vacuum Equipment. BALZERS HIGH VACUUM LTD., 1 Mornington Terrace, Regents Park, London, NW1. High vacuum equipment, oil and rotary pumps, distillation and coating plant. Examples given in folder. 6 pp. ill.

New Books

The Applied Science of Rubber. Edited by W. J. S. NAUNTON. *Edward Arnold.* (168*s*)

Twenty-five contributors with extensive industrial experience have cooperated to produce this comprehensive textbook of rubber technology, which has been prepared with the approval of the Institution of the Rubber Industry.

Boron: Synthesis, Structure, and Properties. Edited by J. A. KOHN, W. F. NYE and G. K. GAULE. *Plenum Press, 227 West 17th Street, New York 11, New York.* ($8·50)

The Conference on Boron sponsored by the Institute for Exploratory Research, US Army Signal Research and Development Laboratory, limited its scope to the solid state physics and chemistry aspects of elementary boron and closely related (high-boron) borides. Altogether 21 papers are reprinted in this volume.

Handbuch der Kältetechnik. Edited by R. PLANK. Volume 3. Verfahren der Kälteerzeugung und Grundlagen der Wärmeübertragung. *Springer-Verlag, Heidelberger Platz 3, Berlin-Wilmersdorf.* (*DM* 84)

The third volume of this monumental German series on the technology of refrigeration contains two parts. The first, by Professor Rudolf Plank of Karlsruhe, consists of a 100 page review of the thermodynamic, electrical and magnetic methods for the production of cold. The second covers heat and mass transfer with special reference to refrigeration: Professor Bachr of Berlin deals with conduction and radiation, while Ernst Hofmann of Wiesbaden treats convective heat transfer and mass transfer.

The Reviewers

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Mr. Herbert Addison, O.B.E., M.Sc., M.I.C.E., M.I.Mech.E., is a consultant and author with special interest in hydraulic engineering. From 1921 to 1951 he was lecturer and professor in hydraulics and hydraulic machines in the faculty of engineering, Cairo University. In 1931 he won the Telford Gold Medal of the Institution of Civil Engineers and in 1938 the Telford Premium. Mr. Addison has made a special study of irrigation and land reclamation projects in various parts of the world. His books include *Land, Water and Food, Sun and Shadow at Aswan, Applied Hydraulics* and *Rotodynamic Pumps*. He is also an honorary fellow of the Institution of Public Health Engineers.

Dr. F. H. Cotton is head of the National College of Rubber Technology, Northern Polytechnic. He is a fellow of the Royal Institute of Chemistry and the Institution of the Rubber Industry and a member of the Plastics Institute. He is also chairman of the joint examinations board of the I.R.I. and P.I.

Simulator for Rough Flying Conditions

A pilot's ability to control a high performance aircraft in bad flying conditions can now be tested on the ground by a machine which has been built for the Ministry of Aviation by Short Brothers and Harland Limited, Belfast.

The machine, which will shortly be delivered to the Royal Aircraft Establishment, Bedford, is known as a "rocking cockpit" or, in full, a flight simulator moving cockpit mechanism. It can move a complete aircraft cockpit just as it would move during high speed flight. For this reason, it is considered to be a marked advance on conventional trainers which, being stationary, cannot give the pilot the sensation of being "thrown around."

The simulator consists of a heavy steel structure surmounted by a wide moveable arm to which an aircraft cockpit will be attached. The arm, powered by two electro-hydraulic servos, can swing the cockpit up and down or tilt it from side to side. These are movements which correspond to pitch and roll in an aircraft. The cockpit will be equipped with standard flying controls which will enable the pilot to govern its attitude in the pitch and roll planes and thus "fly" the simulator.

In simulated still air conditions, the cockpit will be completely under the control of the pilot, but, to test his reactions under very poor flying conditions a specially built analogue computer will feed disturbances into the control system. The computer can be controlled to feed in any desired pattern of disturbances, causing the cockpit to move as it would in an aircraft flying through crosswinds, gusts and turbulence. To keep the cockpit under control, the pilot will then have to counteract the movements initiated by the computer. In other words, he will fly through these adverse conditions exactly as though he were in a real aircraft.

In the roll plane, the cockpit can tilt to 15° from horizontal on each side at a maximum rate of 45° per sec. In pitch, the limits are 20° above horizontal to 10° below, at a maximum rate of 25° per sec. As the pilot is situated at the end of a swinging arm and is approximately 6 ft away from the pitch axis, he can be swung through a large arc.

Because the rates of turn are high—the cockpit can go from horizontal to maximum tilt in any direction in less than one second—safety devices have been incorporated in the simulator's design. Special damping devices at the limits of the systems movement will overrule the pilot's commands should he make an error causing the cockpit to try to go beyond the maximum tilt. The safety mechanism will also go into operation in the case of a runaway in the control circuits. Their function is to slow the system down when it nears maximum tilt, thus avoiding the possibility of hitting the stops at speed.

The wide movable arm to which the chair is attached can swing up and down and tilt from side to side—movements which correspond to pitch and roll in an aircraft.

Progress in Wind Power Generators

Marking 40 years of service to the electrical industry, the 1960 annual report of the Electrical Research Association is now available. Among numerous items of interest contained in the report, mention is made of the present position of wind power developments. During the year ending December, 1960, the scale of effort on this project was reduced, and it was decided that any future work concerned with medium power machines would be merged with a more general study of the problem of electricity supply in remote areas.

There has been continued interest from overseas on the ERA's work on wind power, and the Cranfield research station has received a number of Commonwealth and foreign visitors. Contact has also been maintained with other workers in this field, particularly those in France, Germany, Holland, Denmark, Egypt and India.

Discussions have been held with one of ERA's Canadian members who hopes to be able to design a wind driven generator for use in the Canadian communications network. Such a machine would have to withstand the very severe climatic conditions of a Canadian winter.

A report which gives details of performance tests has been received at ERA headquarters, Leatherhead, from the Electricité et Gaz d'Algérie. This is the authority responsible for the continued development of the 100 kW Enfield-Andreau machine now in continuous service in Algeria.

The Isle of Man Electricity Board has continued to operate a 100 kW wind driven generator connected to the island's supply network and strain gauge measurements have been made on the extruded aluminium blades. Continuous records of output have been taken and these are to be included in one of several reports now being prepared by the ERA.

The onset of fretting corrosion has restricted trials of a 25 kW Dowsett windmill, also installed on this site. Modifications have been made to prevent this trouble recurring, and the machine has been returned to service.

At Achnagoichan, near Aviemore, investigations on the operation of an 8 kW windmill, under practical conditions at the warden's house on the Nature Conservancy Reserve, have been completed and are to be reported.

The second winter season of measurements has been completed at the site of the overhead line test spans between Dalmally and Glenfalloch, Argyllshire. This study of the effect of wind and ice loading on overhead lines in the area of the North of Scotland Hydro-Electric Board has again been hampered by an unusually mild winter, and few results of significance were obtained. The third season of measurements is now in progress.

Finer Analysis with New Polarograph

On the United Kingdom Atomic Energy Authority's stand at the German Chemical Plant Exhibition, which is to be held in Frankfurt from 9 to 17 June, Nash and Thompson Limited will be showing the final prototype of a new differential cathode-ray polarograph. This is a production version of an equipment which was developed by staff of the UKAEA.

The Nashton DCRP, as it is called, can be used as an analytical tool for chemical and metallurgical examinations of many kinds. Among particular applications are soil analysis; studies of the oxygen content of blood plasma; investigations of respiration or photosynthesis in living cells; determination of the inorganic constituents of water, minerals, paints, etc., and the analysis of some organic substances such as dyestuffs.

When used as a means of detecting impurities in foodstuffs, the DCRP can identify traces of metals at concentrations as low as 0·02 parts per million and can carry out quantitative analyses to an accuracy of ± 1 to 2 per cent in solutions containing 1 part per million of the species being investigated.

The DCRP has two identical polarographic cells, which can be used separately or together. There are synchronising devices which ensure that both mercury drop cathodes grow and fall simultaneously in twin cell operation. The two cells are housed in an airtight Perspex chamber, through which a flow of nitrogen is maintained. Nitrogen is also bubbled through the cells themselves before a determination is carried out, to eliminate effects due to dissolved oxygen in the solution.

The cells are fed through tap funnels and exhausted by vacuum suction, so that the working solutions can be removed or replenished without opening the chamber. Mercury can be drained from the cells by means of a separate tap.

The DCRO is claimed to have a greater maximum resolving power than the normal cathode ray polarograph and to be between seven and ten times more sensitive in single cell operation. This is mainly due to the provision of "base line slope compensation," whereby residual currents due to earlier reductions can be cancelled by the application of a small opposing current.

Using two cells, the DCRP is said to be between one and fifty times more sensitive in derivative operation, depending on the resolution required, and ten to eleven times more sensitive by the subtraction method; specially purified agents are not required. In comparative polarography, determinations with a coefficient of variation better than 0·2 per cent are possible. Peak heights can be measured over a maximum height of 100 mm to an accuracy of ±0·5 per cent.

In derivative operation, the trace approximates to the first algebraic derivative of the current waveform for a single cell. Time constant networks of 0·01 or 0·03 seconds can be used to obtain derivative displays of the waveforms produced in a single cell, under subtractive of comparative operation, and second derivative traces in derivative operation. The shorter time constant is used where the highest resolving power is required and the peak heights obtained with maximum sensitivity are about eight times greater than with the ordinary cathode ray polarograph. With the longer time constants, they are said to be about twenty times greater.

How the BBC Get TV Picture Quality

Behind the scenes of the BBC's daily television transmissions there is constant activity, in laboratories, studios, transmitting stations, to produce and maintain the highest standard of picture quality in the world.

PICTURE quality is difficult to define—so many factors are involved—and, in practice, it is equally difficult to assess quantitatively. Nevertheless, sustained efforts have been made over the years to obtain a clear understanding of picture quality in terms of viewer acceptability and to develop techniques for its measurement and control.

A great deal of this work has been carried out by the BBC Designs Department, though there has of course been close cooperation between this department and the well known BBC Research Department at Kingswood Warren. In addition, close liaison is maintained with the research engineers of the General Post Office, since they are responsible for many of the cable and microwave links that are used to connect the BBC's nationwide network of studios and transmitters.

For purposes of engineering measurement and standardization, picture quality can be divided into three main categories: (1) linear waveform distortion, (2) non-linearity distortion, and (3) random noise.

Linear Waveform Distortion

The output of a television camera is in the form of a voltage waveform, in which voltage is proportional to the light intensity of the object being scanned. Since it is this voltage waveform that is ultimately going to produce a visible signal on the receiving cathode ray tube, it must be maintained in its purest form if a high quality final picture is to be achieved.

If the camera tube's voltage output (after being suitably treated) could be injected directly into the viewer's receiver, there would be hardly any problem. However, in practice, there is the transmitter itself and many other links, cables and devices between the camera and the viewer's receiver. It is in these intermediate stages that distortion will inevitably arise unless considerable efforts are made to ensure that faithful reproduction occurs between the input and output voltage of *every* stage. It is very largely through attention to such technical details that the BBC have earned their reputation for world leadership in quality and reliability.

Although a great deal of routine work must be done if high picture quality is to be maintained throughout the day, the work is far from being *all* routine. Television broadcasting is constantly becoming more complex—with increasing activity in national and international links, outside broadcasts, and other factors which increase the amount and complexity of linkage between the television camera and the viewer's receiver.

Constant research and development work, must, therefore, be carried out in order to maintain and, if possible, improve the standards of fidelity in handling the camera's voltage output. To do this, effort in the Designs Department has been centred on two main problems: (1) to obtain an accurate definition of waveform distortion in terms of its limits of acceptability to the viewer, and (2) to obtain means of measuring such distortion quantitatively and quickly.

The linear waveform distortion introduced into a television video signal by any of the complex transmission paths through which it must travel could be assessed by measuring the electrical parameters of the circuit (the amplitude/frequency and phase/frequency characteristics). However, although this kind of procedure is still occasionally used, it is somewhat laborious to operate and the measurements obtained are difficult to correlate closely with the degree of picture impairment that will finally be seen by the viewer.

Since a television signal is in fact a waveform, it seems logical that some sort of waveform should be used to test equipment which must handle the signal. Moreover, by using a waveform test technique, it is possible to decide upon limits of distortion directly in terms of picture impairment. Until recently, the difficulty that has been met with this type of measurement has been in making a suitable choice of test signal. Obviously, the signal must be of the right shape to simulate the important features of a typical television signal. It must also be a signal which can be accurately reproduced to within very close limits, so that the amount of distortion can be assessed, even though the original undistorted waveform is not available at the point where the measurement is being made.

A great deal of credit is due to research engineers of the GPO for the development of such test waveform, which is now in use and is known as a " sine squared pulse and bar." The BBC, who have now adopted this type of test signal, have done a considerable amount of test and development work of their own, to ensure that the signal will meet the needs of day to day operational work, and they have designed special apparatus to generate the signal and measure its distortion.

The requirements on the accuracy of the generated waveform and the high stability that it must maintain are such that the development of suitable apparatus became quite a major project, involving specialised work on many fundamental aspects of circuit design. The designs that were finally arrived at have proved most successful and several commercial organizations have since applied for manufacturing data. As is customary with the BBC, this has been given freely in most cases.

The sine squared pulse and bar signal, as its name implies, consists of a narrow pulse (a squared sine wave) and a long flat bar, with very accurate transitions. The pulse and the bar are related by the fact that one is the differential of the other. These two components represent, respectively, a very narrow dot (a single picture element) and a comparatively large area of uniform tone. It is possible to consider these as being the fundamental components from which a complete television picture is built up.

A further advantage of this waveform is that its bandwidth need be no greater than that of a video signal (3 Mc/s), so that no irrelevent information need be included in the test waveform.

With such an accurately defined waveform, it is possible to use a graticule, in conjunction with a cathode ray oscilloscope monitor, to measure the linear waveform distortion of any length of cable, or other piece of apparatus. The graticule is simply placed over the screen of the oscilloscope so that the display is superimposed on the original waveform and it is then a fairly simple matter to assess the amount of distortion present. In this way, the circuit under test can be given a rating factor which corresponds directly to the quality of the test signal and the degree of final picture impairment.

A photograph of a sine squared pulse with a graticule superimposed can be seen in Fig. 2. The complexity of the graticule is dictated by the fact that several distortions of the pulse, such as variations in amplitude and width and the presence of overshoots, are covered in this graticule. The rating is taken to be that of the defect which has the maximum deviation from the perfect reproduction. The sine squared pulse is used to test the capabilities of the apparatus or system towards the upper end of the frequency range, i.e. towards 3 Mc/s in the British system. The bar signal, which consists of a flat bar repeated at line frequencies, tests the apparatus or system at intermediate frequencies from line frequency up to about 0·5 Mc/s. In addition a bar at field repetition frequency, i.e. 50 c/s, is included to test the system at very low frequencies.

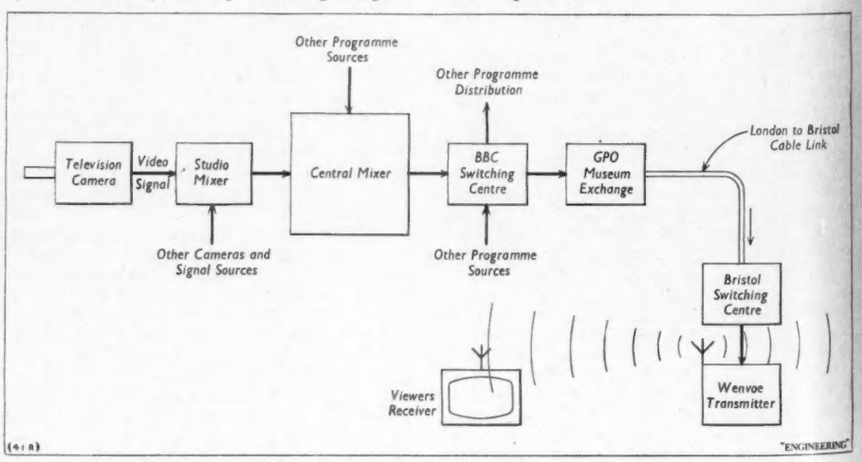

Fig. 1 Simplified diagram of a typical BBC television link, between a London studio and the Wenvoe transmitter.

Research Report

on the work of the

Designs Department, Engineering Division, British Broadcasting Corporation, Broadcasting House, London.

Director of Engineering
SIR HAROLD BISHOP, C.B.E., B Sc., M.I.E.E.

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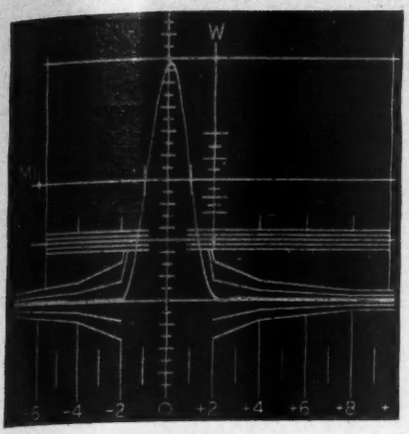


Fig. 2 A sine squared pulse, which is used to assess the amount of linear waveform distortion present in a system, can be seen here, with a test graticule superimposed.

The rating factor allotted to any particular piece of apparatus must depend partly on the difficulty of obtaining the required factor and partly on its complexity. An overall rating from camera input to transmitter output of about 5 per cent can be permitted and this distortion must be divided between individual components of the chain, e.g. a single amplifier may be required to have a rating factor of much less than 0·25 per cent, whereas a long link may be allocated a rating factor as high as 3 per cent, or more.

Non-Linearity Distortion

A further requirement of any apparatus that is to handle a television signal is that the ratio of output to input voltage (the gain) must be constant for all signal levels. If this is not so, then the gradations of the picture will differ from those seen by the camera in the original studio scene.

In bad cases, for example, this type of distortion may take the form of a loss of detail in the shadow regions of the picture, or in the highlight regions.

Another waveform, which has been specially designed for the purpose, is used to test apparatus for this type of distortion. It is in the form of a sophisticated compound signal, known as a "staircase waveform" which consists of a minimum of five steps of equal amplitude between the black level and the white level. These steps, which are illustrated in Fig. 3, should be equal in amplitude to within 1 per cent of the amplitude of each step.

An apparatus for generating this type of signal has also been designed by engineers of the BBC's Designs Department. This is believed to be the most comprehensive and versatile instrument of its kind in use at present. It has a high order of accuracy and is extremely stable in use.

A supplementary but very important use of the bar signal is to assess the very low frequency linearity of the circuit. This will determine whether the system would give rise to a phenomenon known as "bumping." A bump means picture instability whenever there is a sudden transition from nearly black to nearly full white, or vice versa, and it is most irritating to the viewer. This tendency is tested by first applying a waveform consisting of synchronising pulses and black level, and then switching rapidly to a signal with synchronising pulses and a full white bar. If the signal gives rise to a serious periodic instability at very low frequency, which is what is meant by bumping, then an unpleasant form of distortion will result. A satisfactory system must be designed to limit this effect a minimum.

Random Noise

The BBC engineering staff have tackled this problem in two ways. First of all they have carried out an extensive series of subjective tests in order to determine the degree of impairment caused by the various levels and types of random noise. This has established limits to which operational engineers can work. Secondly, the BBC engineers have investigated methods of measuring random noise.

As a consequence of the latter investigations, two methods have been devised for the measurement of random noise. The first is a general purpose method, which has operational simplicity and versatility as its main virtues. The second method, intended to give more detailed information, is particularly concerned with the measurement of random noise associated with camera tubes and camera channels.

The first method is able to measure random noise in the absence of a signal, when superimposed upon the normal synchronising waveform, or upon a signal corresponding to a uniformly illuminated field. It is simple and quick to operate and is capable of measuring signal-to-noise ratios to within 0·5 dB.

The technique uses what is known as a time sampling process, which extracts a sample of the signal from the centre of each successive line of the video waveform. This rejects the video signal components and is thus able to give a power output which is proportional to that of the random noise.

The second method makes use of the fact that the energy in many types of television signal is almost entirely concentrated in the close neighbourhood of the line frequency harmonics, whereas the energy in the random fluctuation noise accompanying the signal has a continuous distribution of frequency. Therefore, by measuring power in a small bandwidth in the centre of an interval between successive harmonics (see Fig. 4), it is possible to obtain a measure of the energy distribution which is unaffected by signal components. As stated previously, this method is of particular value in measuring the noise of camera tubes and their associated channels.

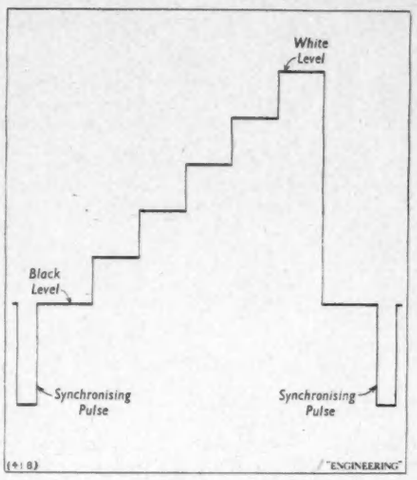


Fig. 3 A "staircase" waveform, which has a number of equal steps between the black and white voltage levels, is used to test for non-linearity distortion.

As a result of the use of this new technique of noise measurement, it has been possible to select and control camera tubes and channels to ensure that the overall random noise level is kept to a minimum at source.

In summing up, it is worth mentioning that the work described in this report forms only a small part of total effort of the BBC Designs Department. The assessment of performance and the development of ways of measuring performance must be accompanied by the design of apparatus which will meet this performance, and a large part of the effort of the department is directed toward this end. In doing this, economic considerations are of primary importance. What is desirable must obviously be balanced against the costs involved and the final aim of the design and development engineer is to reach a stable working system of high quality, which can be provided at a reasonable cost.

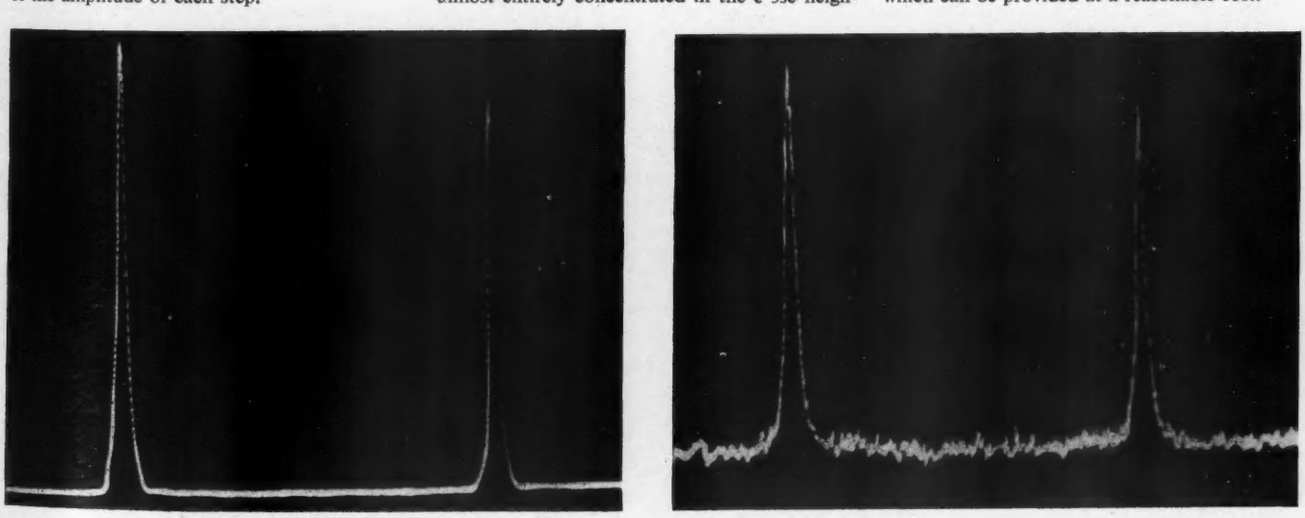


Fig. 4 (Left) Portion of the spectrum of a low-noise video signal, showing two consecutive line frequency harmonics. (Right) Portion of the spectrum of a similar video signal with added random noise.

Insulation for Heat, Damp and Noise

How and how much to insulate are two perennial questions for the householder. As regards insulating for retaining heat, the question probably turns on the relative costs of the work and of the heat lost; insulating for noise has to be assessed on the basis of comfort. Fortunately in many cases heat insulation also acts as a sound barrier.

The " break-even " point for the amount of insulation used must be determined for each individual case. Greater thicknesses are needed for greater temperature differences between inside and outside; if you want to live in a really hot house in a really cold country you must have thick insulation or the heat losses will become excessive. But the problem requires considerable balancing of factors.

If you lag the hot water pipes and tank perfectly you save on fuel for hot water but you lose the radiant heat that otherwise provides some degree of background warmth to the house and which must then be replaced in some other way. Equally you can extract so much heat from the fire that the burnt gases are not hot enough to make a draught in the chimney—a problem also met with in industrial applications.

There is also the associated problem of condensation. If the roof space of a house is so perfectly sealed that perfect heat insulation is achieved, the pores through which the house " breathes " would also be sealed and all moisture would collect and condense at the top with disastrous results to the decoration. An extreme example of this state of affairs is the insulating of greenhouses with a layer of plastic film from which moisture drips to such an extent that plants under the edges of it must be moved out of harm's way. The amount of moisture vapour in a house is surprisingly large: even a sedentary person breathes out one pint in ten hours and water is one of the products of combustion of both gas and oil—not to mention cooking. Condensation in the chimney as a result of cooling the burnt gases too much can cause serious corrosion of the brickwork, and for some modern boiler installations a protection is needed. One such takes the form of a flexible double walled aluminium tube with an insulating layer between. It is made by Uni-tubes of 197 Knightsbridge, London, SW7.

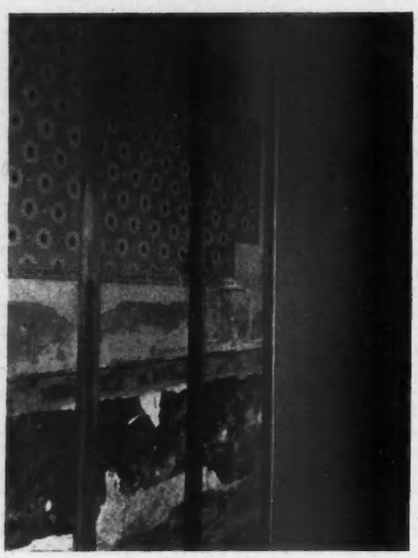
Insulating linings are also used to seal off damp walls and by their nature improve the heat insulation. Considerable information on this problem is given in Digest 9 (second series) of the Building Research Station, Garston, Herts., from which the illustrations are taken. The first shows a method of fixing foil-backed plaster board (an excellent heat insulating medium) over a damp wall by using rot-proofed battens nailed direct to the wall itself by means of chrome steel nails that can be driven into the brickwork without special preparation. The second method illustrated is by using plaster dabs on the wall and fibre board. In a third, ribbons of plaster are laid on the board and this is then offered up to the wall. Such linings have the added advantage that services can be run behind them without interfering with decoration schemes.

An interesting method has been developed by the Building Research Station for locating damp spots by measuring the amount of moisture in the wall. High frequency waves are beamed on the wall and collected on the other side. The amount of absorption of the waves is a direct measure of the moisture content. Hidden leaks and cracks can be quickly located in this way.

Insulating for noise forms the subject of BRS digests Nos. 88 and 89, and suppression of noise caused by domestic equipment is dealt with in No. 7 of the second series. Plumbing naturally features largely in this and it is well to remember that there are less noisy types on the market both on the flushing and filling sections. Noise from central heating equipment is becoming more noticeable particularly with the increased use of pump circulated systems. But here again care in the choice of pump makes a big difference and the insertion of a length of flexible pipe in the system can prevent the transmission of noise from one part to another. Slamming doors, squeaky boards, and noises from metal roofs (including birds walking over them) are also mentioned.

Some ideas on the sound insulation of moveable partitions are included in Digest 2 of the second series. The difficulties are the lightweight material of which such a barrier is usually made and the large air gaps at top and bottom—it is in fact an exaggerated condition of that found with all doors.

The whole question of sound and thermal insulation is dealt with in some detail in two papers presented (in 1959) to the Royal Society for the Promotion of Health by Mr. E. F. Stacey and Mr. J. Churton, both of the Building Research Station.



Two methods of fixing insulating linings. Left, using battens nailed to the wall, and right, using plaster dabs. (Crown Copyright, reproduced by permission of the Controller HMSO).

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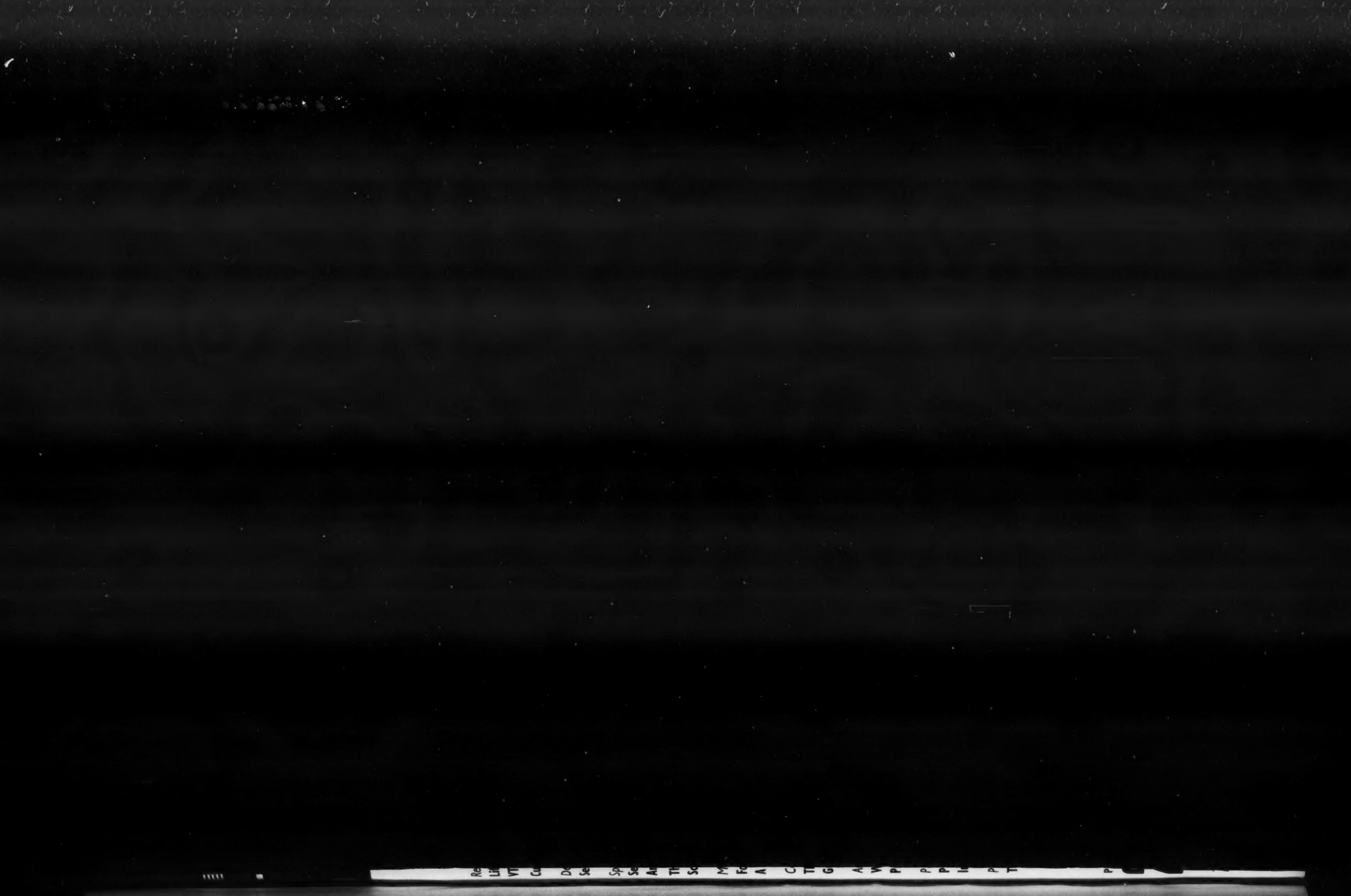
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